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ANNUAL REPORT

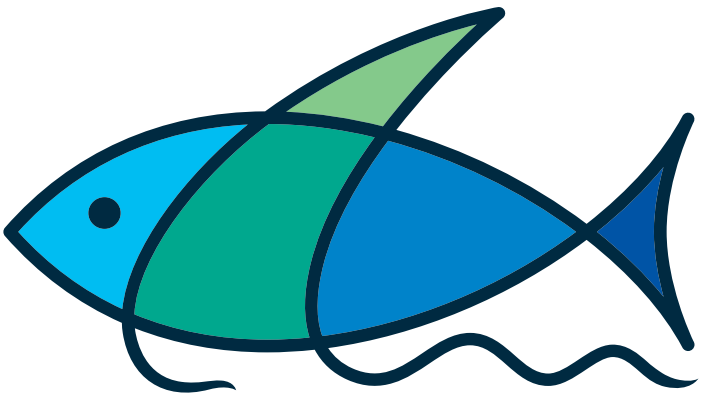
Ashtamudi short-neck clam
India's first ecolabelled fishery

India's first ecolabelled fishery

Ashtamudi Short-neck Clam

CMFRI's initiatives in studying and managing the short-neck clam (*Paphia malabarica*) fisheries of Ashtamudi Lake since the 1990s helped the WWF, India in identifying this small-scale fisheries as an ideal candidate for MSC certification. After three years of concerted effort, the WWF and CMFRI have together achieved a landmark in Indian fisheries by obtaining MSC certification for the shortnecked clam fishery of Ashtamudi Lake, Kerala in November, 2014.

ANNUAL REPORT 2014-15



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CMFRI

Indian Council of Agricultural Research

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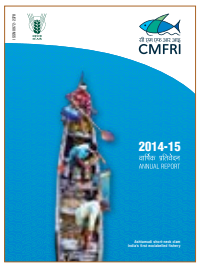

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CONTENT

MANDATE

To monitor the exploited and under-exploited marine fisheries resources of the Exclusive Economic Zone (EEZ)

To understand the fluctuations in abundance of marine fisheries resources in relation to change in the environment

To develop suitable mariculture technologies for finfish, shellfish and other culturable organisms in open seas to supplement capture fishery production

To act as a repository of information on marine fishery resources with a systematic database

To conduct transfer of technology, post-graduate and specialised training, education and extension-education programmes

To provide consultancy services

TOP 10
Achievements in 2014-15

1. Responsible for science back-up for MSC ecolabel for the Ashtamudi Lake short- neck clam fishery - which is the first certified fishery in the country meting global standards in fisheries management

2. Developed an anti-diabetic nutraceutical from red and brown seaweeds

3. Eight new marine fishes new to science described

4. Minimum legal size (MLS) of 58 species of marine fishes defined and recommended of the Govt. of Kerala

5. Internationally renowned marine scientist Dr. Trevor Charles Platt FRS joined CMFRI as Jawaharlal Nehru Science Fellow, DST, Govt. Of India at CMFRI, Kochi on 7th November 2014.

6. Georeferenced 1260 out of 1511 marine fish landing centers in India for geospatial mapping of fisheries

7. Integrated Multi-trophic Aquaculture (IMTA) demonstrated Kappaphycus cultured with cobia resulting in 50% increase in yield of sea weeds

8. Policy guidance on (Fish Aggregating Device) FAD based for cuttlefish fishery published

9. 'Choose Wisely' sustainability labeling for ITC restaurants serving sea food facilitated

10. Guidance on National Plan of Action (NPOA) for elasmobranch fishery formulated

Others

- CMFRI Cochin becomes an ISO 9001:2008 certified Institution for administration and management of marine fisheries and mariculture research activities

- CMFRI bagged the Indira Gandhi Rajbhasha Puraskar for the third time for the excellent work and commendable achievements in the implementation of Official Language Policy during the year 2012-13 for the category of Autonomous Bodies in Region 'C'.

PREFACE

Indian marine fisheries sector is developing and growing at a fast pace and once again, I feel happy and elated to present the significant scientific and technological contributions that Central Marine Fisheries Research Institute (CMFRI) has been able to provide towards enhancing marine fisheries production and bring about qualitative change to those dependent on marine fisheries for their livelihood.

This year again (2014), we released the data on Marine Capture Fisheries of India through a press conference. Marine fish production recorded 3.6 million tonnes, with Gujarat, Tamil Nadu and Kerala being the top producers of marine fish in the country. CMFRI plays a major role in providing scientific and technical support in the form of advisories for the effective and sustainable management of major fisheries. A major step in this direction was the policy guidelines formulated for Fish Aggregating Device (FAD) based cuttle fish fishery, which was provided to the Government of Karnataka. Also, Minimum Legal Size (MLS) of 58 species of marine fishes were defined and advisories provided to the Government of Kerala for implementation and sustainable management of these species. The marine policy series on National Plan of Action of Sharks in India has been prepared to provide a definitive action plan for the sustainable exploitation, conservation and protection of the elasmobranchs.

A major achievement this year was the certification of the short neck clam (Paphia malabarica) fishery of the Ashtamudi Lake as per the global standards of sustainability of the Marine Stewardship Council (MSC). It is significantly, the first small scale fishery to be certified from India.

It is an honour and privilege to CMFRI that the internationally renowned marine scientist Dr. Trevor Charles Platt, FRS, Plymouth Marine Laboratory has joined CMFRI on a Jawaharlal Nehru Science Fellowship, Department of Science and Technology, Government of India on the 7th November 2014. Dr Platt has immense experience in marine ecology with expertise in satellite based marine optics and CMFRI shall be benefited hugely from his expertise and experience.

In a major initiative to address specific issues affecting as well sustaining marine fisheries, CMFRI has entered into a Memorandum of Understanding with National Institute of Oceanography (CSIR-NIO), Goa to undertake focused collaborative research on oceanographic aspects such as the bio-geo-chemical processes in the formation of mud banks, trophodynamics

and impact of climate change on the fishery along the Indian Coast.

The institute has also succeeded in producing a nutraceutical product from seaweeds, the third of its kind, which will aid in treatment/control of diabetics. The product will be launched shortly.

In our efforts to develop and promote fish production through mariculture, cage culture operations demonstrated through Integrated Multi Trophic Aquaculture (IMTA) were carried out at several Centres. Besides these, a mega project, All India Network Project (AINP) in mariculture, will be initiated shortly with active multi-institutional and multi-locational operations.

CMFRI has described 8 marine fish species which are new to science, jointly with National Bureau of Fish Genetic Resources (NBFGR) Cochin Centre.

Dissemintaion and sharing of scientific knowledge and data is also one of our major activity and CMFRI joined hands with Marine Biological Association of India (MBAI) and organized Marine Ecosystems Challenges and Opportunities 2 (MECOS 2). In this conference, all scientists who participated in the first International Indian Ocean Expedition (IIOE) were felicitated to mark the 50th year of IIOE. We further enhanced our capability to acquire data through organized sea cruises by acquiring a new Research Vessel, R V Cadalmin I.

CMFRI has a new-look and dynamic website and we continue to maintain third position in the accession of our e-prints from the CMFRI repository.

Krishi Vigyan Kendra (KVK) of CMFRI continued with several outreach activities and the 'Pokkali' brand of rice produced wholly organically is worth appreciating.

CMFRI is, now, a lot stronger with 29 new recruits of Agriculture Research Service (ARS) scientists from varied disciplines, who have joined during the last three years and I am confident that the youngsters will not only infuse new energy and talent into the system and contribute to the development of marine fisheries but also continue to uphold the legacy of CMFRI.

Finally, I acknowledge the support of all scientists and staff of CMFRI, Deputy Director General (Fisheries) and all in the Fisheries Division of ICAR and Director General ICAR in the progress of CMFRI.

30 June 2015
Kochi

A. Gopalakrishnan
Director, CMFRI

EXECUTIVE SUMMARY

Central marine fisheries research institute being one of the foremost fisheries research organisation in the country, the research projects implemented by institute lead to outcomes that are momentous to the entire marine fisheries sector of India. The year 2014-15 also saw a remarkable amount of research work in the Institute, with a cluster of 70 research projects, exactly half of which were in-house projects and the rest were externally funded. In addition, CMFRI also executed 11 consultancy projects. This report presents the research outcomes covering 13 distinct themes with focus on addressing issues related to sustainable exploitation of marine fishery resources, development of viable, eco-friendly mariculture technologies as well as conservation and management of marine biodiversity.

In 2014, the all India marine fish landings were estimated at 3.6 million t, registering a 5% decline compared to the production in 2013. Gujarat, Tamil Nadu and Kerala remained as the top three marine fish producing states since 2006 and together contributed 54% to the total marine fish landings of the country, with Gujarat and Tamil Nadu holding the first and second positions respectively. Marine fish landings in Gujarat were estimated at 7.12 lakh t registering a slight decline from the 7.17 lakh t in the preceding year. Maharashtra also registered 5.4% decrease in the marine landings over the previous year contributing 3.44 lakh t. Total estimated marine fish landings in Karnataka and Goa were 4.74 and 1.86 lakh t respectively in 2014. Total catch in Karnataka was 20% above five year average (2009-2013) and in Goa 135% above the five year average catch during the same period. Improved catches of oilsardine, and increased operations of large meshed purseseines resulting in better exploitation of large pelagics resulted in increased overall catches in both the states. Total marine fish landings in Kerala were estimated at 5.76 lakh t registering a decline of 15% compared to the 6.71 lakh t that landed during 2013. Landings of all major demersal and pelagic resources declined contributing to an overall decrease of 1.28 lakh t. Total marine fish production in Tamil Nadu (TN) was estimated at 6.6 lakh t and that in Puducherry at 0.66 lakh t. Andhra Pradesh recorded all time high (since 1985) marine fish landings of 3.42 lakh t in 2014, contributed mainly by pelagic groups (67%).

The total production by trawlers along the northeast coast of India was 2.39 lakh t, registering a decrease by 26% when compared to the 3.25 lakh t that landed in 2013. In Odisha, the trawl catch was 0.89 lakh t forming 64.4% of the total marine catches. In West Bengal, 0.16 lakh t was landed by trawlers at the catch rate of 33.2 kg h^{-1} forming 20.6% of the total landings. The production of elasmobranchs in India in 2014 was estimated at 47242 t with sharks forming 42.5% followed by skates (4.8%) and rays (52.7%). Major contributing states to the elasmobranch fishery were Gujarat (28.3%) and Tamil Nadu (23.7%). Annual landings of bivalves in India were estimated at 1.34 lakh t, contributed mainly by clams (81.1%) oysters (11.2%) and mussels (7.8%). The estimated bivalve production registered an increase of 18% when compared to the previous year (1.14 lakh t).

The initiatives of CMFRI in studying and managing the short-necked clam (*Paphia malabarica*) fisheries of Ashtamudi Lake since the 1990s helped the WWF, India in identifying such small-scale fisheries as ideal for certification of sustainability from the Marine Stewardship Council (MSC). CMFRI and WWF have together achieved a landmark in Indian fisheries by obtaining an MSC certification for the short-necked clam fishery of Ashtamudi Lake, Kerala in November, 2014, which is the first certified fishery in the

country meeting global standards in fisheries management.

Towards geospatial mapping of marine fish landings, Geographical Information System (GIS) based inventory of fish landing centres was accomplished during the year. In the Chlorophyll-based Remote-sensing Assisted Forecasting System (ChloRIFFS) project, new attempts have been initiated to suitably modify the common optical algorithms used in remote sensing based assessment of Net Primary Productivity (NPP) whereby exogenous factors could be incorporated at the tertiary level. An attempt was made using a combination of R software and SeaDAS interface on Chl-A data.

Population genetic structure of Indian oilsardine was studied using mitochondrial control region markers by analysing samples from 9 locations across the range of distribution. Haplotype values were very high and nucleotide diversity values very low indicating recent demographic expansion of Indian oilsardine populations. Morphotypes of Indian oilsardine showed significant differences in morphometric analyses and nutritional comparisons. A functional gene, myostatin was amplified in red snapper (*Lutjanus argentimaculatus*), which regulates growth negatively, and hence myostatin gene knock-out studies could be initiated to enhance growth rate in culture conditions. Stress responsive genes involved in acid, salt and thermal tolerance were identified from marine microalgae, which were functionally characterised and validated. H+ ATP synthase gene which is involved in intracellular pH homeostasis and various abiotic stresses were identified and validated from the microalga *Dictyosphaerium ehrenbergianum*. The gene Fructose-1,6-Bisphosphate Aldolases (FBA) involved in regulating hyperosmotic stress was identified from *Tetraselmis indica*. *Scenedesmus* FKBP12 gene capable of imparting temperature and salinity tolerance was isolated and validated from the thermophilic *Scenedesmus* sp.

Long pepper incorporated as a phytostimulant in feed was found to enhance maturation and spawning in *Etroplus suratensis*. Indigenously developed live feed enrichment emulsions were developed as cost effective import substitutes for fish larval nutrition. Nutritional profiling in selected commercially exploited cephalopods revealed unique fatty acid and amino acid profiles. Microbound diets developed for sand lobster (*Thenus unimaculatus*) larval nutrition was proved to be an alternative to live feed with good acceptability.

Myxosporeans belonging to two families, Ceratomyxidae (*Ceratomyxa* sp.) and Myxididae (*Myxidium* sp., *Zschokkella* sp.) were recorded in ornamental fishes. Myxosporean infections of *Ceratomyxa diamanti* was identified in *Etroplus suratensis* and *Etroplus maculatus* using molecular tools. Screening of cage reared finfishes for the presence of viral nervous necrosis (VNN), an OIE listed viral disease, showed absence of infection, except in tilapia. Heavy infection of white spot syndrome virus (WSS) was recorded in marine lobsters from the open sea cages in Tamil Nadu. Infections with the OIE listed parasites, *Bonamia* and *Perkinsus* were confirmed in bivalve samples using molecular diagnostics. *Amyloodinium ocellatum* infestation was investigated in cage farmed seabass. RNA2 encoding coat protein of Beta Noda Virus was recombinantly expressed using prokaryotic expression system. Three different DNA vaccine constructs were prepared using vibrio antigens.

An anti-diabetic product with activity against type-II diabetes was developed from a blend of marine macroalgae. The product was compared with that of standard drugs after administering to the test animals with streptozotocin (a diabetes inducer). It has been validated by *in vitro* and *in vivo* animal models and is ready for licensing. Presence of phenolics (3.50 mg/GAE) with antioxidant properties was identified in the black clam *Villorita cyprinoides*. Potential use of the red seaweed, *Hypnea musciformis* as an antioxidant and activities of various solvent extracts of seaweeds *Jania rubens* and *Kappaphycus alvarezii* as a food ingredient, were evaluated. Aqueous extract of the seaweed *Turbinaria conoides* was purified to obtain an Oligofucan enriched seaweed concentrate (OESC). Solvent extracts of *Pteroeides esperi* (sea pen) were purified to yield piperazine derivative, 3-omega fatty acid and sterol derivative.

Coral diversity, fish assemblage and diversity of sponges and other bio-resources associated with coral reefs of Gulf of Kutch and selected islands of the Lakshadweep Archipelago (Kadamat, Amini, Kavarathi, Chetlat and Kiltan) were surveyed following the Line Intercept Transect (LIT) and Underwater Visual Census (UWVS) methods. Prevalence of disease conditions and bleaching in the coral reefs was also documented. Devagad

Island off the Karwar Coast was selected for assessing Island biodiversity and valuation of the services provided by the Island ecosystem. Two underwater surveys were carried out to assess the diversity of finfish, seaweed, echinoderms, molluscs, crustaceans, phytoplankton, zooplankton and corals. Impacts of fishing gears on the fishery and biodiversity loss were studied. A study on the fishers' perception regarding impact of gears on the fishery and biodiversity loss in the Saurastra region revealed that there was declining catch in the near shore waters (upto 25 m depth) which resulted in the extension of the current fishing ground. Biodiversity valuation of marine ecosystems along the Indian coast revealed that coastal zone population was increasing, while the area of mangroves, length of mangrove fringed coastline and area of coral reefs showed declining trends. Integrated taxonomic investigations of 15 species of deep sea shrimps were carried out. Geospatial distribution and diversity of fished taxa along the Indian coast were analysed and average taxonomic distinctness and variation in taxonomic distinctness were worked out for 75 fishing zones. With 76 new additions, the Marine Biodiversity Museum now holds 2034 specimens.

With round the year spawning of cobia and pompano in RAS, CMFRI has achieved a milestone in the breeding of high value marine finfishes. With continuous refinement of hatchery technology, survival and production of cobia and pompano seeds were increased considerably. Farmers were benefited with the supply of about 2.5 lakh cobia and pompano seeds for farming operations. The success achieved in seed production of Indian pompano and orange spotted grouper will facilitate the introduction of two more species for commercial farming. With the high demand for mussel seeds for farming, nursery rearing methods for mussel spat is being improved.

Cage culture technology developed by CMFRI has been adopted by more number of farmers across the country with high success rate. Considering the importance of mariculture to the national food security, ICAR has sanctioned the prestigious 'All India Network Project on Mariculture' to CMFRI, which will pave the way for the overall development of mariculture sector of the country. Integration of seaweed farming with marine cage farms to augment the production and to create balanced systems for environmental stability is a new initiative towards sustainable farming.

Fluctuations in sardine landings were monitored and found to correlate with climate changes. Biogeochemical processes in the clam beds in Ashtamudi Lake were monitored. Clam beds in Karnataka were also monitored for their ecological health. Investigations on ecobiology and fisheries of mud banks of Kerala revealed that fishing area shifts between mud bank and non-mud bank area according to shoal movement. The bottom dwelling teleost *Trypauchen vagina* could be identified as an indicator species for sea bottom related disturbances. *Trichodesmium* blooms were observed before mud bank formation and *Fragilaria* sp. was observed during the mud bank period. Seabirds were documented for their abundance. A liquid seaweed fertilizer has been developed and tested. Seaweed production from Tamil Nadu coast was estimated and reasons for yield reduction in seaweed mariculture were identified. The "Mad crab" art work, using plastics was installed at Fort Cochin beach to create awareness among the public regarding harmful impact of plastics littered on the beaches.

In the National Initiative for Climate Resilient Agriculture (NICRA) project, seasonal distribution pattern of tunas were studied. Investigations on Sea Surface Temperature (SST) as well as rainfall and the impact on pelagic fishery resources along the Gujarat Coast, development of an informatics tool to run a regional model on air temperature *vs.* SST, impact of climate change on trawl catch rates and carbon footprint contribution of marine fisheries activities at selected fishing harbours of Andhra Pradesh and Tamil Nadu were some the major outcomes from the NICRA project.

The economic value of marine fish landings in India during 2014 was estimated at Rs. 31750 crores at landing centre (LC) level and Rs. 52360 crores at the retail market (RM) level, which registered an increase of 8.10% and 12.1% respectively over 2013. The estimated private capital formation (investment) in Indian marine fisheries sector was worked out to Rs. 21023 crores out of which the investment in mechanised sector shared 92% followed by motorised sector (7%) and traditional sector (1%). The average input-output ratio of different craft gear combinations ranged from 0.40 to 0.72 in the mechanised sector, 0.31 to 0.42 for the motorised sector and around 0.11 to 0.22 for the non-mechanised sector. At the national level, the marine fish marketing efficiency

(per cent share of fishermen in consumer's rupee) was 61% (2014), a reduction of 3.5% compared to 2013. The Ecosystem Based Responsible Fisheries Management (EBRFM) entry points and subsequent prioritisation, were identified through co-learning sessions conducted in different locations in Kerala, Tamil Nadu and Karnataka and capacity deficiency matrices were prepared. The level of performance and empowerment index of 100 Self Help Groups (SHGs) from selected maritime locations in Kerala, Karnataka and Tamil Nadu, with fishery based micro enterprises were assessed and the success cases of Entrepreneurial Capacity Building were documented, with special reference to the gender perspective.

CMFRI-ATIC/KVK sales counter was opened at CMFRI, Kochi as a joint initiative of Krishi Vigyan Kendra (KVK), Narakkal and Agriculture Technology Information Centere (ATIC) of CMFRI for supplying organic/safe farming inputs. KVK also initiated farm gate markets in pokkali fields, satellite production centres for supplying quality seeds, marketing of exclusive feed for pearl spot, open precision farming in vegetables and formation of vegetable task force. Four hundred fifty fishermen and fish farmers benefitted through the various products and services of KVK.

CMFRI received the Indira Gandhi Rajbhasha Puraskar from the Hon'be President of India on 14 September 2014, for the excellent work and commendable achievements in the implementation of the Official Language, under the category of Autonomous Bodies in Region 'C'.

Eprints@CMFRI is ranked 352nd among world repositories and 3rd among Indian repositories. Among ICAR institutes, Eprints @ CMFRI continues to be in the first position.

On balance, the year 2014-15 was without doubt a fruitful year for CMFRI with such a plethora of successful projects in varied fields, each one with its own significant outcomes.

कार्यकारी सारांश

देश के सब से प्रमुख मात्स्यिकी अनुसंधान संस्थान के रूप में सी एम एफ आर आइ द्वारा कार्यान्वित परियोजनाएं भारत के समूचे मात्स्यिकी सेक्टर के लिए महत्वपूर्ण बन गई हैं. वर्ष 2014-15 के दौरान संस्थान में कई उल्लेखनीय अनुसंधान कार्य हुए हैं, जिनमें 70 अनुसंधान परियोजनएं हैं और इनमें आधा गृहांदार परियोजनाएं और बाकी बाहरी निधि की परियोजनाएं. इनके अतिरिक्त सी एम एफ आर आइ ने 11 परामर्श परियोजनाओं का भी निष्पादन किया है. यह रिपोर्ट समुद्री मात्स्यिकी संपदाओं के टिकाऊ विदोहन, शक्य एवं पर्यावरण अनुकूल प्रौद्योगिकियों का विकास तथा समुद्री जैवविविधता के प्रबंधन आदि विभिन्न 13 विषयों से जुडी हुई समस्याओं पर प्रकाश डालती है.

वर्ष 2014 में अखिल भारतीय समुद्री मछली अवतरण 3.6 मिलियन टन आकलित किया गया है, जो वर्ष 2013 की अपेक्षा 5% कम है. वर्ष 2006 तक गुजरात, तमिल नाडु और केरल सबसे अधिक मछली उत्पादन करने वाले राज्य थे. तीनों राज्यों का योगदान देश के कुल समुद्री मछली उत्पादन का 54% था और उत्पादन में गुजरात और तमिल नाडु क्रमश: प्रथम और द्वितीय स्थान पर थे. गुजरात में समुद्री मछली अवतरण 7.12 लाख टन आकलित किया गया, जो पिछले वर्ष के 7.17 लाख टन की तुलना में थोड़ा कम था. महाराष्ट्र के 3.44 लाख टन के मछली उत्पादन में भी पिछले वर्ष की अपेक्षा समुद्री मछली अवतरण में 5.4% की कमी आकलित की गयी. वर्ष 2014 के दौरान कर्नाटक और गोवा का कुल समुद्री मछली अवतरण क्रमश: 4.74 और 1.86 लाख टन आकलित किया गया. कर्नाटक में कुल मछली पकड़ पिछले पांच वर्षों (2009 - 2013) के औसत से 20% ऊपर थी और गोवा में भी इस अवधि के दौरान की मछली पकड पिछले पांच वर्षों के औसत से 135% ऊपर थी. दोनों राज्यों में तारली की बेहत्तर पकड और बड़ी जालाक्षि वाले कोष संपाशों के अधिकाधिक प्रयोग से समूची पकड़ में बडी वेलापवर्ती मछलियों का बेहत्तर विदोहन दृश्यमान था. केरल का कुल समुद्री मछली अवतरण 5.76 लाख टन आकलित किया गया, जो वर्ष 2013 के 6.71 लाख टन की तुलना में 15% कम था. सभी प्रमुख तलमज्जी एवं वेलापवर्ती संपदाओं के अवतरण में 1.28 लाख टन की घटती देखी गयी. तमिल नाडु का कुल समुद्री मछली उत्पादन 6.6 लाख टन आकलित किया गया और पुदुचेरी में 0.66 लाख टन आकलित किया गया. आंध्रा प्रदेश में दीर्घ काल के बाद (वर्ष 1985 से लेकर) वर्ष 2014 में 3.42 लाख टन का बेहत्तर समुद्री मछली अवतरण आकलित किया गया, जिसमें वेलापवर्ती मछलियों का प्रमुख योगदान (67%) महसूस हुआ.

भारत के उत्तर पूर्व तट पर आनायकों द्वारा कुल मछली उत्पादन 2.39 लाख टन आकलित किया गया और इस में वर्ष 2013 के 3.25 लाख टन के अवतरण की तुलना में 26% की घटती थी. उड़ीषा में आनाय द्वारा की गयी पकड़ 0.89 लाख टन आकलित की गयी, जो कुल समुद्री मछली पकड़ का 64.4% थी. पश्चिम बंगाल में आनायकों द्वारा 33.2 कि.ग्रा. h^{-1} की दर में 0.16 लाख टन की मछली का अवतरण किया गया, जो कुल अवतरण का 20.6% था. वर्ष 2014 में भारत में उपास्थिमीनों का

उत्पादन 47242 टन आकलित किया गया, जिस का 42.5% सुराएं था और इस के बाद स्केट (4.8%) और रे मछली (52.7%) अधिक मात्रा में देखी गयीं. उपास्थिमीनों का अधिकाधिक योगदान करने वाले राज्य गुजरात (28.3%) और तमिल नाडु (23.7%) थे. भारत में द्विकपाटियों का वार्षिक अवतरण 1.34 लाख

टन आकलित किया गया, जिस में प्रमुख सीपी (81.1%), शुक्ति (11.2%) और शंबु (7.8%) थे. आकलित किए गए द्विकपाटी उत्पादन में पिछले वर्ष (1.14 लाख टन) की तुलना में 18% की वृद्धि महसूस हुई.

सी एम एफ आर आइ द्वारा 1990 के वर्षों से लेकर अष्टमुडी झील की छोटी गला युक्त सीपी (*पाफिया मलबारिका*) की मात्स्यिकी पर किए जाने वाले अध्ययन एवं प्रबंधन ऐसी एक लघु पैमाने की मात्स्यिकी को डब्लियु डब्लियु एफ, भारत को मराइन स्टिवार्डशिप काउन्सिल (एम एस सी) के टिकाऊपन के प्रमाणीकरण के लिए चुनने में सहायक निकले. केरल के अष्टमुडी झील की छोटी गला युक्त सीपी मात्स्यिकी को नवंबर, 2014 में एम एस सी प्रमाणीकरण प्राप्त करना, जो मात्स्यिकी प्रबंधन में विश्व स्तर का मान पूरा करने वाली देश की प्रथम प्रमाणित मात्स्यिकी है, सी एम एफ आर आइ और डब्लियु डब्लियु एफ की भी महत्वपूर्ण उपलब्धि है.

वर्ष के दौरान समुद्री मछली अवतरण के भू-स्थानिक मानचित्रण की दिशा में, मछली अवतरण केन्द्रों का भौगोलिक सूचना व्यवस्था (जी आइ एस) पर आधारित आविष्कार किया गया. क्लोरोफिल पर आधारित दूर संवेदन की सहायता से पूर्वानुमान प्रणाली (**ChloRIFFS**) परियोजना में, निवल प्राथमिक उत्पादकता (एन पी पी) के दूर संवेदन पर आधारित निर्धारण में उपयुक्त किए जाने वाल सामान्य ऑप्टिकल अलगोरितम में उचित सुधार लाने के लिए नए प्रयासों का प्रारंभ किया गया, जिससे तृतीयक स्तर पर बहिर्जात कारकों को भी समाविष्ट किया जा सकता है. इस के अंदर **Chl-A** आंकडे पर **R** सोफ्टवेयर और **SeaDAS** इन्टरफेस के सम्मिलन उपयुक्त करके प्रयास किया गया.

भारतीय तारलियों के वितरण के परास के 9 स्थानों से संग्रहित नमूनों का विश्लेषण करते हुए माइटोकोन्ट्रियल कन्ट्रोल रीजियन मार्केर्स उपयुक्त करके इन मछलियों की जीवसंख्या आनुवंशिक संरचना पर अध्ययन किया गया. हाप्लोटाइप मूल्यता उच्च मात्रा में थी और न्यूक्लियोटाइड विविधता मूल्यता बहुत कम थी, जो भारतीय तारलियों के जनसांख्यिकीय विस्तार का संकेत देता है. भारतीय तारलियों के मोर्फोटाइपों से मोर्फोमेट्रिक विश्लेषण और पौष्टिकता तुलनाओं के बीच का महत्वपूर्ण अंतर व्यक्त हुआ. रेड स्नापर मछली (*लूटजानस अर्जेन्टिमाकुलेटस*) में मयोस्टेटिन, जो एक क्रियात्मक जीन है, परिवर्धित करने से मछली की बढ़ती पर विपरीत असर होता है. इसलिए पालन स्थितियों में, मछली की बढ़ती में वृद्धि लाने के लिए मयोस्टेटिन जीन निकालने पर अध्ययन प्रारंभ करना आवश्यक है. समुद्री सूक्ष्मशैवालों से अम्ल, लवणता और तापीय सह्यता में शामिल दबाव अनुक्रियाशील जीनों की पहचान की गयी और इनका क्रियात्मक विशेषीकरण और विधिमान्यकरण किया गया. सूक्ष्मशैवाल *डिक्टियोस्फीरियम एरेनबर्गियानम* से अंतराकोशिकीय **pH** होमियोस्टासिस और विभिन्न अजैविक दबावों के कारक **H+ATP** सिन्तेस जीन की पहचान की गयी और इसका विधिमान्यकरण भी किया गया. *टेट्रासेल्मिक इंडिका* से हाइपरोस्मोटिक दबाव नियमित करने लायक फ्रक्टोस-1, 6-बाइसफोस्फेट आल्डोलेसस (एफ बी ए) जीन की पहचान की गयी, थीमोफीलिक *सेनेडेस्मस* जाति से तापमान और लवणता सह्यता के लिए सक्षम सेनेडेस्मस **FKBP12** जीन का विलगन और विधिमान्यकरण किया गया.

एट्रोप्लस सुराटेन्सिस के परिपक्वन और अंडजनन बढ़ाने में इस मछली के खाद्य में पादप उत्तेजक के रूप में लोंग पेप्पर सम्मिलित करना अच्छा देखा गया. मछली डिंभकों के पोषण के लिए लागत प्रभावी विकल्प के रूप में देशज जीवंत खाद्य संवर्धन मिश्रण विकसित किए गए. चुने गए वाणिज्यिक तौर पर विदोहित शीर्षपादों में पौष्टिकता प्रोफाइलिंग करने पर अनन्य वसा अम्ल और अमिनो अम्ल प्रोफाइल प्रकट हुए. रेती महाचिंगट (*थीनस यूनीमाकुलेटस*) के डिंभक के पोषण के लिए माइक्रोबाउन्ड आहार अच्छी स्वीकार्यता का वैकल्पिक आहार साबित हुआ.

अलंकारी मछलियों में दो कुटुम्बों, जोकि सेराटोमाइक्सिडे (सेराटोमिक्सा जाति) और माइक्सिडिडे (*माइक्सिडियम* जाति, *ज़ोक्केल्ला* जाति) के माइक्सोस्पोरियनों की रिकार्ड की गयी. आण्विक औजार उपयुक्त करके *एट्रोप्लस सुराटेन्सिस* और *एट्रोप्लस माकुलेटस* में *सेराटोमिक्सा डयामन्टी* का मिक्सोस्पोरियन संक्रमण की पहचान की गयी. वाइरल नेर्वस नेक्रोसिस (वी एन एन), जो ओ आइ ई के अंदर सूचीबद्ध विषाणुजनित रोग है, की उपस्थिति जानने के लिए पिंजरे में पालित पखमछलियों की जांच करने पर तिलापिया मछली के अलावा और किसी मछली में संक्रमण नहीं देखा गया. तमिल नाडु के खुले सागर पिंजरों में पालित समुद्री महाचिंगटों में वाइट स्पोट सिन्ड्रोम वाइरस (डब्लियु एस एस) का भारी संक्रमण देखा गया. आण्विक निदान उपयुक्त करके द्विकपाटियों के नमूनों में ओ आइ ई के अंदर सूचीबद्ध परजीव, *बोनामिया* और *पेरकिनसस* का संक्रमण की पुष्टि की गयी. पिंजरे में पालित समुद्री बास मछली में

अमिलूडिनियम ओपेल्लाटम का संक्रमण देखा गया. प्रोकारियोटिक एक्स्प्रशन प्रणाली से बीटा नोडा वाइरस का **RNA2** एनकोडिंग कोट प्रकट हुआ. विब्रियो एन्टिजन उपयुक्त करके तीन विभिन्न डी एन ए टीका विकसित की गयीं.

समुद्री सूक्ष्मशैवालों के मिश्रण से टाइप-**II** डायबेटस के खिलाफ एक एन्टी-डायबेटिक उत्पाद विकसित किया गया. परीक्षण जीवों में स्ट्रेप्टोज़ोटोसिन (एक डायबेटस उत्प्रेरक) के साथ दिए जाने पर यह व्यक्त हुआ कि यह उत्पाद मानक दवाओं के बराबर है. इस दवा का पशु नमूनों में पात्रे और जीवे परीक्षण विधिमान्य हो गए है और लाइसेन्स के लिए तैयार है. काली सीपी *विल्लोरिटा साइप्रिनोइडस* में एन्टीओक्सिडन्ट गुण सहित फीनोलिक्स (3.50 मि.ग्रा./जी ए ई) की उपस्थिति की पहचान की गयी. एन्टीओक्सिडन्ट के रूप में लाल शैवाल हिपनिया म्यूसिफोर्मिस के संभावित उपयोग और खाद्य पदार्थ के रूप में समुद्री शैवाल *जानिया रूबेन्स* और *कापाफैकस अलवरेज़ी* के विलायक सार की सक्रियता का मूल्यांकन किया गया. ओलिगोफ्यूकान एनरिच्ड सीवीड कोन्सेन्ट्रेट (ओ ई एस सी) प्राप्त करने हेतु समुद्री शैवाल *टर्बिनेरिया कोनोइडस* को शुद्ध किया गया. पिपेरेज़िन यौगिक, 3-ओमेगा वसा अम्ल और स्टिरोल यौगिक प्राप्त करने के लिए *प्टीरोइडस एसपेरी* (समुद्री पेन) को शुद्ध किया गया.

लाइन इन्टरसेप्ट ट्रान्सेक्ट (एल आइ टी) और अन्डरवाटर विश्वल सेन्सस (यु डब्लियु वी एस) तरीकों से कच्छ की खाड़ी और लक्षद्वीप समूह के चुने गए द्वीपों (कडमत, अमीनी, कवरती, चेतलत और किल्टन) के प्रवाल भित्तियों से जुडी हुई प्रवाल विविधता, मछली समुच्चयन और स्पंज एवं अन्य जैव संपदाओं का सर्वेक्षण किया गया. प्रवाल भित्तियों में रोग का फैलाव और विरंजन देखा गया. द्वीप जैवविविधता निर्धारण और द्वीप की आवास व्यवस्था द्वारा प्रदान की गयी सेवाओं के मूल्यांकन के लिए कारवार के देवगड द्वीप को चुना गया. पख मछलियों, समुद्री शैवालों, शूलचर्मियों, मोलेस्कों, क्रस्टेशियनों, पादपप्लवकों, प्राणिप्लवकों और प्रवालों की विविधता का निर्धारण करने के लिए दो जलांदर सर्वेक्षण चलाए गए. मात्स्यिकी पर मत्स्यन गिअरों के संघातों और जैवविविधता ह्रास पर अध्ययन किया गया. सौराष्ट्र क्षेत्र पर मात्स्यिकी पर मत्स्यन गिअरों के संघातों और जैवविविधता ह्रास के बारे में मछुआरों की अवधारणा यह थी कि तटीय समुद्र (25 मीटर की गहराई तक) में घटती हुई मछली पकड़ की वजह से वर्तमान मत्स्यन तल का विस्तार किया गया. भारतीय तट की समुद्री आवास व्यवस्था की जैवविविधता का मूल्यांकन करने से यह मालूम पडा कि तटीय मेखला की आबादी बढ़ती जा रही है, बल्कि मैंग्रोव क्षेत्र, मैंग्रोव युक्त तटरेखा और प्रवाल भित्तियों के क्षेत्र कम होने की प्रवणता है. गहरे समुद्र के महाचिंगटों की 15 प्रजातियों के वर्गीकरण पर समन्वित जांच की गयी. भारतीय तट के भू-स्थानिक वितरण और फिश्ड टाक्सा की विविधता का विश्लेषण किया गया और 75 मत्स्यन मेखलाओं में औसत वर्गिकी स्पष्टता और वर्गिकी स्पष्टता में विभिन्नता पर आकलन किया गया. समुद्री जैवविविधता संग्रहालय में अब 76 नए जोड़ों के साथ कुल 2034 नमूने मौजूद हैं.

पुनःपरिसंचरण जलकृषि व्यवस्था में पूरा वर्ष कोबिया और पोम्पानो मछलियों का अंडजनन कराने में हासिल की गयी सफलता से सी एम एफ आर आइ ने उच्च मूल्य वाली पख मछलियों के प्रजनन में महत्वपूर्ण उपलब्धि हासिल की है. स्फुटनशाला प्रौद्योगिकी में लगातार सुधार लाने से कोबिया और पोम्पानो मछलियों के संतति उत्पादन और अतिजीवितता में विचारणीय वर्धन हुआ है. मछुआरों को पालन करने के लिए कोबिया और पोम्पानो मछलियों के करीब 2.5 लाख संततियों का वितरण किया गया. भारतीय पोम्पानो मछली और संतरा रंग की चित्तियों वाली ग्रूपर मछली के संतति उत्पादन में हासिल की गयी सफलता से वाणिज्यिक पालन किए जाने वाली मछलियों में और दो प्रजातियाँ भी जोडी जाएगी. पालन के लिए शंबु के संततियों की बढ़ती हुई मांग की वजह से शंबु स्पैटों के नर्सरी पालन के तरीकों में सुधार लाया जा रहा है.

सी एम एफ आर आइ द्वारा विकसित पिंजरे में मछली पालन की प्रौद्योगिकी देश के विभिन्न भागों के असंख्य मछुआरों द्वारा स्वीकार की गयी है. राष्ट्रीय खाद्य सुरक्षा में समुद्री संवर्धन की प्रधानता को मानते हुए भा कृ अनु प ने सी एम एफ आर आइ को प्रतिष्ठित 'समुद्री संवर्धन पर अखिल भारतीय नेटवर्क परियोजना' मंजूर की है और इस परियोजना से देश के समुद्री संवर्धन के क्षेत्र के समग्र विकास की रास्ता खोला जाएगा. मछली उत्पादन बढ़ाए जाने और पर्यावरण स्थिरता कायम रखने के लिए समुद्री पिंजरों के साथ समुद्री शैवाल का समेकित पालन टिकाऊ पालन रीति की ओर एक नया पहल है.

तारली मछली के अवतरण में हुए उतार-चढ़ाव का पुनरीक्षण किया गया और इसका जलवायु परिवर्तन से

सहसंबंध देखा गया. अष्टमुडी झील के सीपी संस्तरों में बयोजियोकेमिकल प्रक्रियाओं की निगरानी की गयी. कर्नाटक के सीपी संस्तरों के पारिस्थितिकी स्वास्थ्य की निगरानी भी की गयी. केरल के मड बैंक के पर्यावरण जीवविज्ञान और मात्स्यिकी पर जांच करने पर यह व्यक्त हुआ कि मछली झुंडों के संचलन के अनुसार मत्स्यन क्षेत्र में मड बैंक और नोन-मड बैंक क्षेत्रों के बीच परिवर्तन होते हैं. निचले भाग में वास करने वाल टेलियोस्ट *ट्रिपॉचेन वजाइना* को समुद्र के निचले भाग में होने वाली अव्यवस्थाओं पर संकेत करने वाली प्रजाति के रूप में पहचान की जा सकती है. मड बैंक के रूपायन से पहले *ट्राइकोडेस्मियम* फुल्लिकाओं की उपस्थिति और मड बैंक रूपायन के दौरान *फ्राजिलेरिया* प्रजाति की उपस्थिति देखी गयी. समुद्री पक्षियों को भी प्रचुर मात्रा में देखा गया. एक तरल समुद्री शैवाल उर्वरक विकसित किया गया और इसका परीक्षण भी किया गया. तमिल नाडु तट के समुद्री शैवाल उत्पादन का आकलन किया गया और समुद्री शैवाल के संवर्धन में हुई कमी का कारण भी पहचाना गया. समुद्री पुलिनों में छोडे जाने वाले प्लास्टिक के बुरे असर पर आम लोगों के बीच अवगाह जगाने के लिए फोर्ट कोचीन के पुलिन में प्लास्टिक से निर्मित 'पागल केकड़ा' कला सृष्टि की स्थापना की गयी.

जलवायु लचीला कृषि के लिए राष्ट्रीय पहल (एन आइ सी आर ए) परियोजना में, ट्यूना मछली के मौसमिक वितरण रीति पर अध्ययन किया गया. गुजरात तट पर समुद्री सतह तापमान (एस एस टी) तथा बारिश एवं वेलापवर्ती मात्स्यिकी संपदाओं पर होने वाले संघात पर जांच, वायु का तापमान एवं एस एस टी पर क्षेत्रीय नमूना चलाने के लिए इन्फोर्माटिक टूल का विकास, आनाय द्वारा पकड़ दर पर जलवायु परिवर्तन का संघात और आंध्रा प्रदेश तथा तमिल नाडु के चुने गए मत्स्यन पोताश्रयों में समुद्री मात्स्यिकी गतिविधियों का कार्बन फुटप्रिन्ट योगदान आदि एन आइ सी आर ए परियोजना के कुछ प्रमुख परिणाम हैं.

वर्ष 2014 के दौरान भारत के समुद्री मछली अवतरण का आर्थिम मूल्य अवतरण केन्द्रों (एल सी) के स्तर पर 31750 करोड रुपए और खुदरा बाजार (आर एम) के स्तर पर 52360 करोड रुपए आकलित किया गया, जिसमें वर्ष 2013 की अपेक्षा 8.10% और 12.1% की वृद्धि दृश्यमान थी. भारतीय समुद्री मात्स्यिकी सेक्टर में आकलित निजी पूंजी (निवेश) 21023 करोड रुपए थी और इसमें 92% का हिस्सा यंत्रीकृत सेक्टर का है बाकी हिस्सा मोटोराइस्ड सेक्टर (7%) और परंपरागत सेक्टर (1%) का है. यंत्रीकृत सेक्टर में विभिन्न यान संभार संयोग के अनुपात का परास 0.40 से 0.72 के बीच था और मोटोरीकृत सेक्टर में यह 0.31 से 0.42 और अयंत्रीकृत सेक्टर में 0.11 से 0.22 के बीच आकलित किया गया. राष्ट्रीय स्तर पर समुद्री मछली विपणन क्षमता (मछुआरे का प्रतिशत हिस्सा ग्राहक के रुपए में) 61% था (2014), जो वर्ष 2013 की तुलना में 3.5% कम था. केरल, तमिल नाडु और कर्नाटक के विभिन्न स्थानों में आयोजित सह-पढ़न सत्रों द्वारा आवास व्यवस्था पर आधारित उत्तरदायित्वपूर्ण मात्स्यिकी प्रबंधन (ई बी आर एफ एम) के एन्ट्री पोइन्ट और परिणामस्वरूप प्राथमिकता की पहचान की गयी और क्षमता की कमी के मैट्रिस तैयार किए गए. केरल, कर्नाटक और तमिल नाडु के चुने गए समुद्री स्थानों के 100 स्वयं सहायक संघों के निष्पादन स्तर और सशक्तीकरण सूचक का मात्स्यिकी पर आधारित माइक्रो एन्टरप्राइसेस के साथ निर्धारण किया गया और लिंग परिप्रेक्ष्य में उद्यमिता क्षमता निर्माण में सफलता के मामले प्रलेखित किए गए.

कृषि विज्ञान केन्द्र (के वी के), नारक्कल और सी एम एफ आर आइ के कृषि प्रौद्योगिकी सूचना केन्द्र (ए टी आइ सी) के संयुक्त पहल के रूप में जैव सुरक्षित पालन सामग्रियों के वितरण के उद्देश्य से सी एम एफ आर आइ, कोच्ची में सी एम एफ आर आइ-ए टी आइ सी/ कृ वि कें विपणन काउन्टर का परिचालन शुरू किया गया. कृ वि कें ने भी पोक्काली खेत के फार्म गेट मार्केट, गुणता युक्त बीजों के वितरण के लिए साटलाइट उत्पादन केन्द्र, केवल पेर्ल-स्पोट मछली के लिए खाद्य, तरकारीके लिए ओपन पेर्सिशन फार्मिंग और तरकारी कार्य दल का रूपायन आदि अभिगम की शुरुआत की हैं. कृषि विज्ञान केन्द्र के विभिन्न उत्पादों और सेवाओं से लगभग चार सौ पचास मछुआरे एवं किसान लोग लाभान्वित हुए हैं.

सी एम एफ आर आइ को राजभाषा के उत्कृष्ट निष्पादन के लिए 'ग' क्षेत्र के स्वायत्त संगठनों के अंदर दिनांक 14 सितंबर 2014 को इंदिरा गांधी राजभाषा पुरस्कार प्राप्त हुआ.

विश्व की रिपोसिटरियों में **Eprints@CMFRI** का 352वां स्थान और भारत की रिपोसिटरियों में 3वां स्थान है. भा कृ अनु प के संस्थानों में **Eprints@CMFRI** प्रथम स्थान पर है.

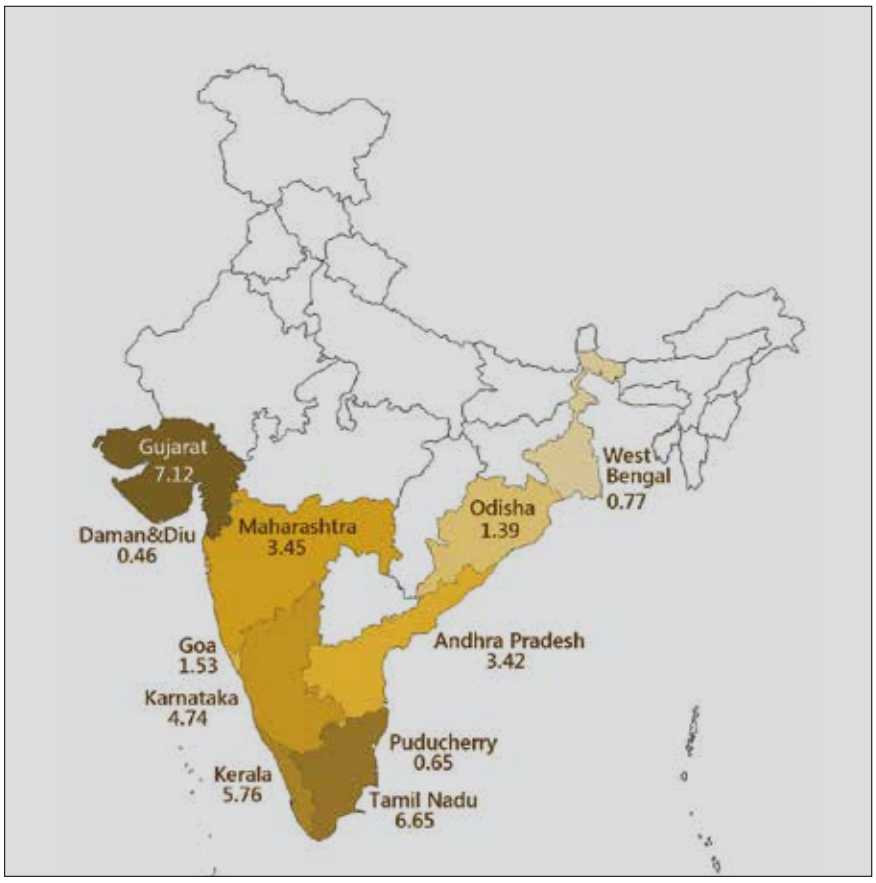
संक्षिप्त में, वर्ष 2014-15 विभिन्न विषयों में सफल परियोजनाओं और महत्वपूर्ण परिणामों के साथ सी एम एफ आर आइ के लिए सफलतायुक्त वर्ष था, इस में संदेह नहीं.

FISHERY RESOURCE MONITORING

Fish harvests

Research Project: FISHCMFRISIL201200100001

Species-wise and gear-wise estimates of marine fish landings and gear-wise fishing effort were made for the year 2014 using data collected from landing centres and fishing harbours belonging to 75 different fishing zones of the 9 maritime states and two union territories based on the stratified multi-stage random sampling design developed by CMFRI. The database on marine fish

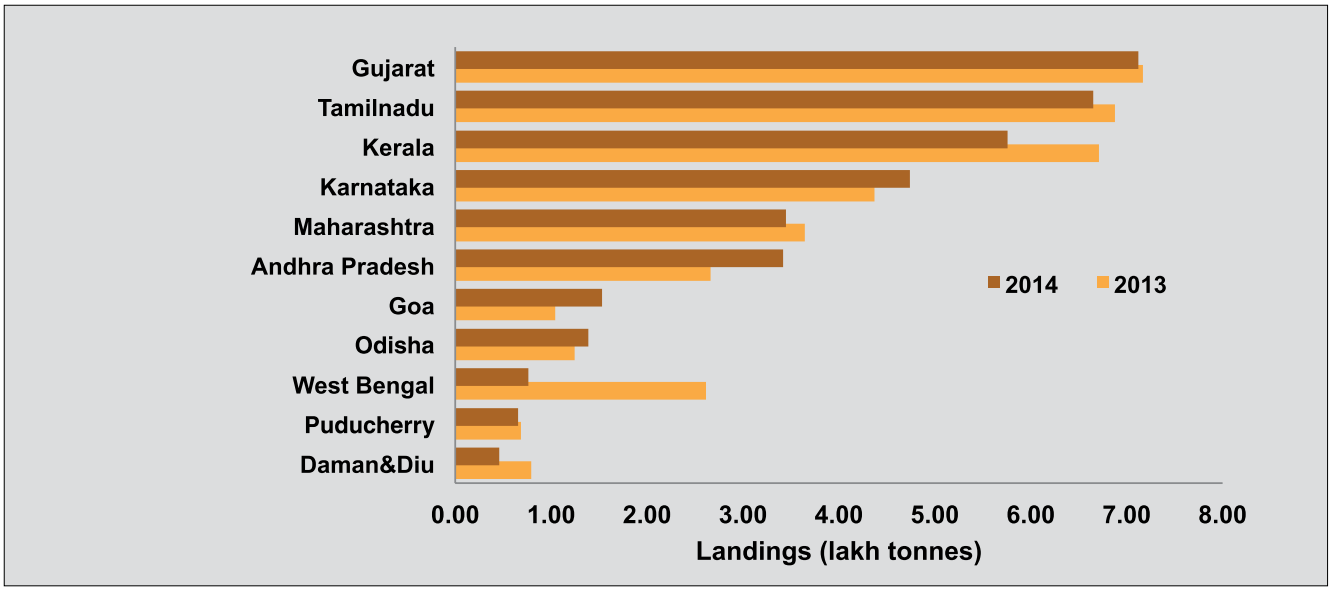


State-wise marine fish landings estimate for 2014

landings was updated with the generated information on species, fishing zone, gear, landings and respective fishing effort both in terms of fishing units and fishing hours.

In 2014, marine fish landings estimated for the mainland of India amounted to 3.59 million tonnes, registering a 5% decline compared to the production in 2013. Gujarat, Tamil Nadu and Kerala remained as the top three marine fish producing states in the country since 2006. These states represented 54% of the total marine fish landings, with Gujarat and Tamil Nadu holding the first and second positions in both 2013 and 2014.

All the maritime states except Andhra Pradesh, Karnataka, Odisha and Goa recorded reduced landings compared to 2013.

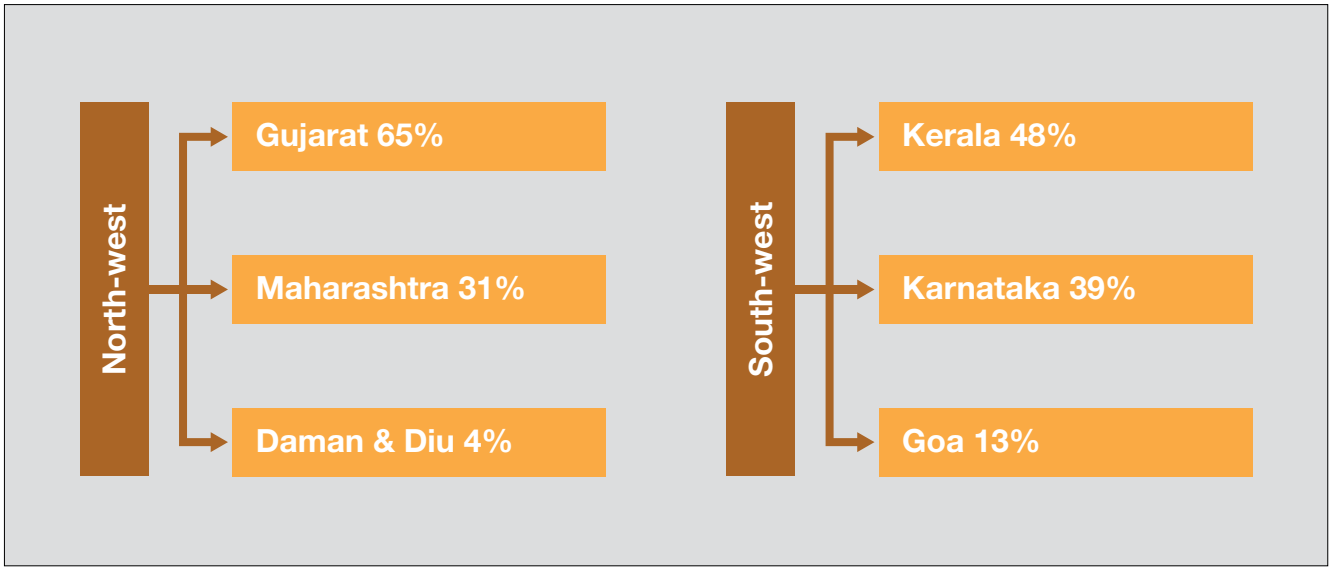


State-wise marine fish landings in and 2014 and 2013

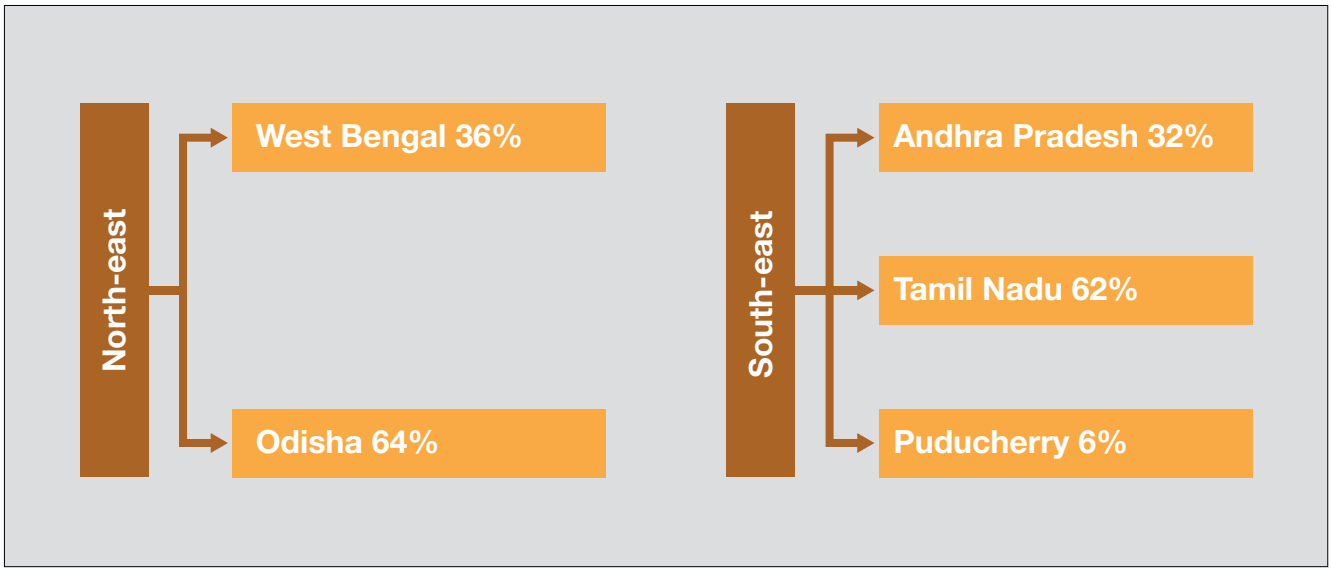
The west-coast of India contributed significantly to the total marine fish landings and it accounted for 64% of landings. The south-west region comprising the states of Kerala, Karnataka and Goa was the top contributors to the national figures with 33%, while the north-west region comprising Maharashtra, Gujarat and Daman & Diu was placed second with 31% contribution. Marine fish production from Kerala has shown a decline over last two years, mainly because of decline in the landings of oil sardine. Landings from Karnataka showed a positive growth during the current year with an increase of about 37,000 t. In Goa the estimated landings is 1.53 lakh t with an increase of about 50,000 t, due to the increased landings (75,000 t) of oilsardine during this year.

The north west region consisting of Maharashtra and Gujarat witnessed a decline of 58,000 t in 2014, with marginal decline in all maritime states. Gujarat accounted for 65% of the landings of north-west region with an estimate of 7.12 lakh t.

The share of south-east region consisting of Andhra Pradesh, Tamil Nadu and Puducherry was 30% with an estimate of 10.72 lakh t. An increase of about 75,000 t was noticed in Andhra Pradesh mainly due to the increased landings of mackerel, lesser sardines and tunnies, whereas a declining trend



Contribution of states in north-west and south-west region landings



Contribution of states in north-east and south-east region landings

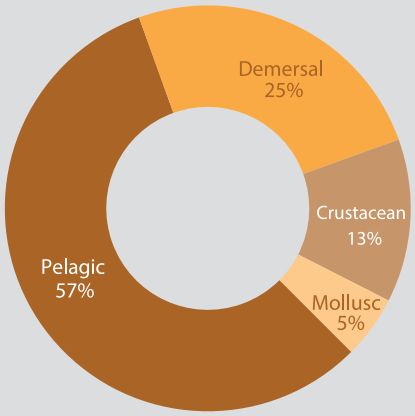
was noticed in Tamil Nadu and Puducherry.

The north-east region with West Bengal and Odisha as constituent states, contributed to the tune of 6% to the total landings. In West Bengal, the catches have declined more dramatically, from 2.62 lakh t in 2013 to 0.76 lakh t in 2014 owing to the marked drop in the operation of mechanized fishing crafts due to non-profitability. In addition, Hilsa catch in West Bengal observed a heavy decline from 39,010 t in 2013 to meager 3,340 t in 2014. A marginal increase of 15,000 t was noticed in the landings of Odisha mainly due to the increased landings of ribbonfishes and carangids.

The assemblage-wise breakup indicated that the pelagic finfishes contributed 57% along with demersal finfishes, crustaceans and molluscs whose contributions were 27%, 13% and 5%, respectively.

Major Pelagics (Lakh t)	
Oilsardine	5.45
mackerel	2.37
Carangids	2.10
Ribbonfishes	2.09
Other sardines	2.06

Crustaceans (Lakh t)	
Penaeid prawns	2.06
Non-penaeid prawns	1.83
Crabs	0.46
Stomatopods	0.24

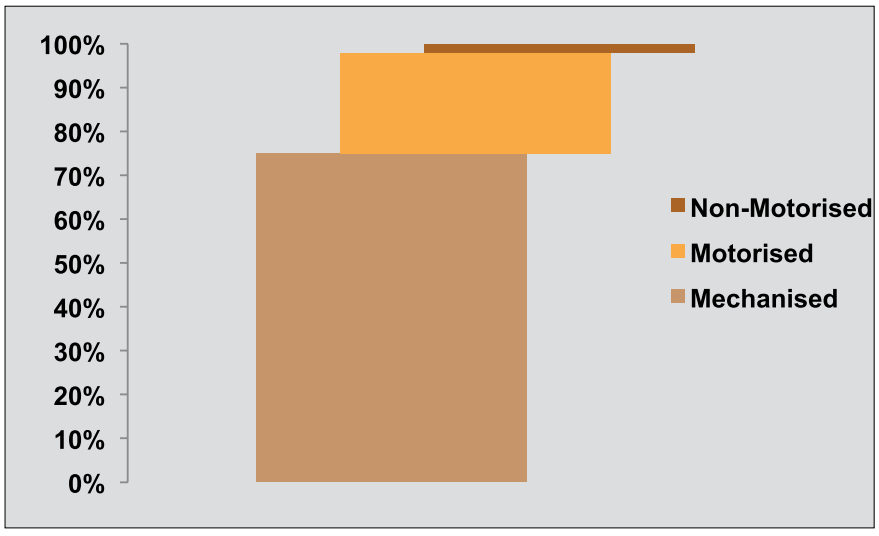


Major Demersal (Lakh t)	
Perches	2.46
Croakers	1.62
Silverbellies	1.25
Catfishes	0.69
Lizard fishes	0.54

Molluscs (Lakh t)	
Cephalopods	1.73
Bivalves	0.04
Gastropods	0.02

Assemblage-wise marine fish landings and major resources in each assemblage

The year 2014 witnessed decline in landings by mechanised sector whose contribution is 75% of the annual catch, the fall being 5% as compared to the previous year while motorised sector observed an increase of 4%. The share of non-mechanised sector has remained rather stable at 2%.



Sector-wise Contribution during 2014

Estimated Marine Fish Landings (tonnes) in India 2014			
Pelagic finfish		Demersal finfish	
CLUPEIDS		ELASMOBRANCHS	
Wolf herring	20282	Sharks	22479
Oil sardine	544684	Skates	2471
Other sardines	206310	Rays	22334
Hilsa shad	5247	Eels	9544
Other shads	16578	Catfishes	68675
ANCHOVIES		LIZARD FISHES	54202
Coilia	29751	PERCHES	
Setipinna	4850	Rock cods	32144
Stolephorus	57893	Snappers	8283
Thryssa	51051	Pig-face breams	13968
Other clupeids	69987	Threadfin breams	136931
Bombayduck	112646	Other perches	55037
Half beaks & full beaks	6552	Goatfishes	22085
Flying fishes	4004	Threadfins	9499
Ribbon fishes	209405	Croakers	161864
CARANGIDS		Silverbellies	124535
Horse Mackerel	37822	Big-jawed jumper	6921
Scads	86172	POMFRETS	
Leather-jackets	15240	Black pomfret	18131
Cobia	3159	Silver pomfret	30191
Coryphaena	8890	Chinese pomfret	1870
Other carangids	58886	FLAT FISHES	
MACKERELS		Halibut	1784
Indian mackerel	237056	Flounders	244
Other mackerels	375	Soles	51088
SEER FISHES		Crustaceans	
Scomberomorus commersoni	31412	Penaeid prawns	205602
Scomberomorus guttatus	17684	Non-penaeid prawns	183405
Scomberomorus lineolatus	12	Lobsters	1568
Acanthocybium spp.	101	Crabs	46061
TUNNIES		Stomatopods	24266
Euthynnus affinis	36894	Molluscs	
Auxis spp.	10991	Mussels, Oysters and Clams	134235#
Katsuwonus pelamis	11124	Other Bivalves	3828
Thunnus tonggol	9937	Gastropods	1951
Thunnus albacares	16922	Cephalopods	
Other tunnies	2973	Squids	83223
BILL FISHES		Cuttlefish	84081
Marlin	3476	Octopus	5909
Sailfish	3999	Others	
Swordfish	1759	Seaweeds	18890 #
Barracudas	19609	Miscellaneous	137759
Mullets	6792	**Total**	**3745978**
Unicorn cod	395		

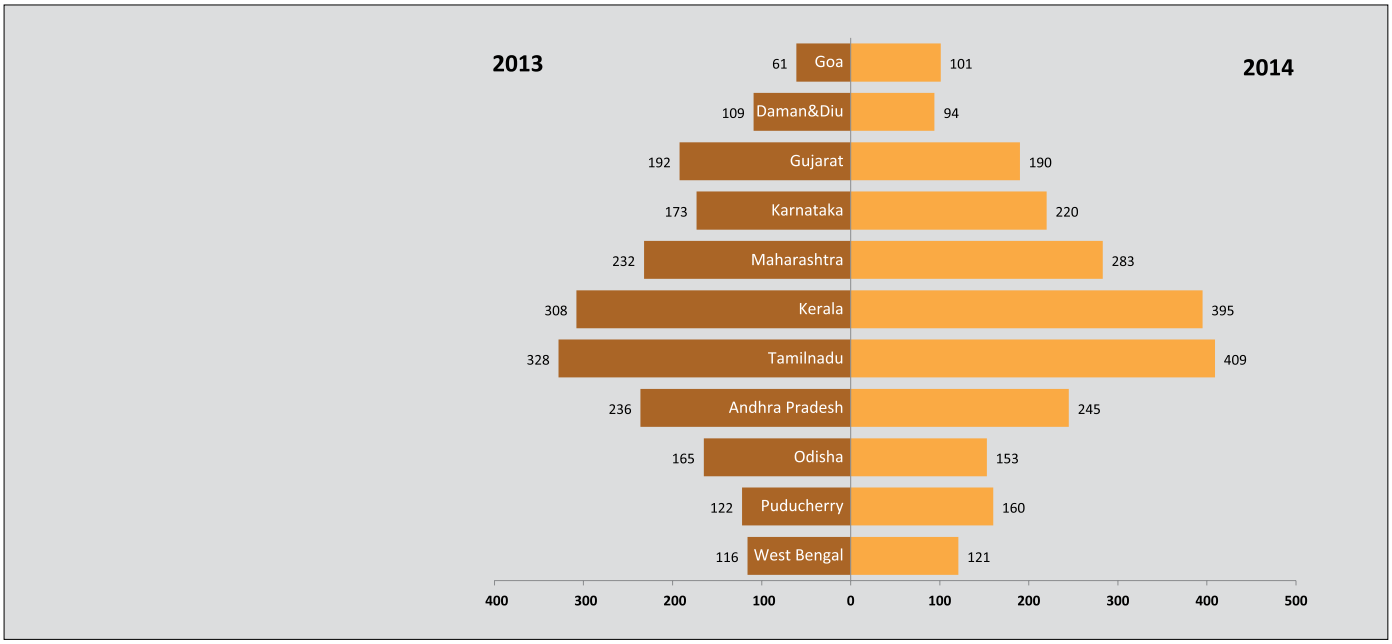
The estimates are based on an alternate method and are excluded from the comparisons which is based on total landings of 3592853 t.

Major resources landed (lakh t) and percentage of maximum contributing state			
Oil sardine	5.45	Kerala	28%
Indian mackerel	2.37	Karnataka	29%
Perches	2.46	Gujarat	25%
Carangids	2.10	Kerala	26%
Ribbonfishes	2.09	Gujarat	48%
Penaeid prawns	2.06	Kerala	19%
Other sardines	2.06	Tamil Nadu	54%
Non-penaeid prawns	1.83	Gujarat	58%
Cephalopods	1.73	Gujarat	33%
Croakers	1.62	Gujarat	34%

Amongst resources oil sardine (*Sardinella longiceps*), topped the list as in 2013 with a contribution of 15% to the total marine fish landings in the country. Indian mackerel (*Rastralliger kanagurta*) was the second important resource after oil sardine with a share of 6.6%. The other important resources were carangids (5.85%), ribbon fishes (5.83%), lesser sardines (5.74%), penaeid prawns (5.72%) and non-penaeid prawns (5.1%).

Species diversity in landings

The information generated in 2014 indicated that 653 marine species landed along the Indian coast, which belonged to 311 genus, 150 family, 45 order, 10 class and 5 phylum. Alpha diversity was high for Tamil Nadu, followed by Kerala and Maharashtra and the lowest was for Damen & Diu, being relatively smaller region. Average taxonomic distinctness, the most preferred diversity measure, was high for Gujarat even though the alpha diversity was less than half of that for Tamil Nadu indicating that the species landed in Tamil Nadu are taxonomically more related compared to those landed in Gujarat.

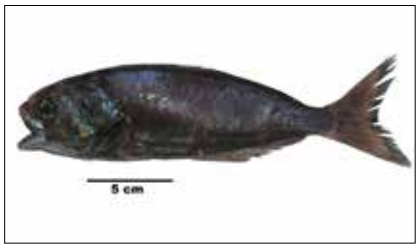


Number of species landed in each maritime state during 2013-14

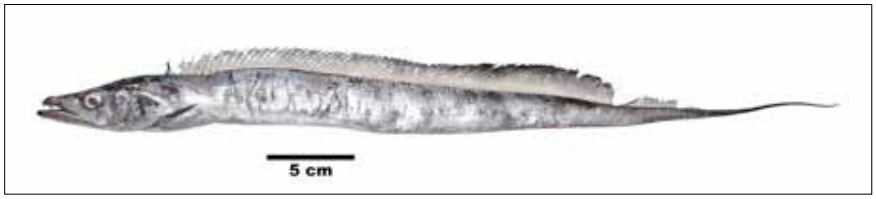
Assessment of Deep-sea resources of the continental slope of Indian EEZ

Research Project: EF-2/MoES

An exploratory deep sea fishing cruise on-board FORV SagarSampada (cruise 332) was conducted on the southwest coast and Cape Comorin region of the Indian EEZ during November 24 - December 10, 2014. Fishing using trawlnets such as HSDT - CV and HOT was carriedout in 200m and 1000m stations in 6 transects off Valappad, Kochi, Alappuzha, Kollam, Trivandrum and Cape Comorin. In the transect off Alappuzha, a heavy catch of around two tonnes of the Indian ruff *Psenopsis cyanea* at 225m depth was obtained. An edible species, it is also regularly observed as by-catch in commercial trawl landings at Cochin Fisheries Harbour. A catch of around 10 tonnes of the ribbonfish *Trichiurus auriga* (Pearly hairtail) was obtained off Trivandrum at 285m depths. This species grows to a maximum length of 35cm only and is often mistaken as juveniles of the commercially important *Trichiurus lepturus* (Large head hairtail) which can grow up to 235cm.



Indian Ruff *Psenopsis cyanea*



Pearly hairtail *Trichiurus auriga*

Ribbonfish *T. auriga* enmeshed in the trawl net

FISHRIES AND ECOSYSTEM MODELING

GIS based fisheries management

Research project: FISHCMFRISIL201200900009

As the major objective of the project is to bring all fishery related information in a GIS platform, data are being collected and analysed from all gears (trawl, gillnet, purseseine, ringseine, dolnet, hook and line and traditional gears) at ten research centres of CMFRI covering all maritime States and Union Territories in the mainland. GIS and Remote Sensing software with three licences was procured and installed at three centres of the Institute (Mangalore, Veraval and Visakhapatnam) as a preliminary step for making resource maps of marine fishery resources and their abundance along Indian coast in space and time. Regional training cum workshop for operating the software was conducted after installation, for the project associates and scholars.

Inventory of marine fish landing centres in GIS platform

GIS based Inventory of fish landing centres was planned and accomplished. This database is being prepared especially to bring together information on the fishery operations which do not generally use GPS and those using GPS for their navigation in GIS platform.

Data incorporated in the inventory are - name of fish landing centre, its location with latitude and longitude (GPS reading), district, gears operated from the landing centre, seasonality of operation of each gear, distance covered for fishing from the centre and seasonal changes in direction of fishing activity. List of dominant species in each gear from each fishing centre is also incorporated in the inventory. The database which is in MS Excel format has provision for data updating. Data collection from about 1260 landing centres along the Indian coast was completed.To facilitate easy retrieval of required data, a software named *LandingGIS* was also developed. Database stored in CD is in the final stages of scrutiny.

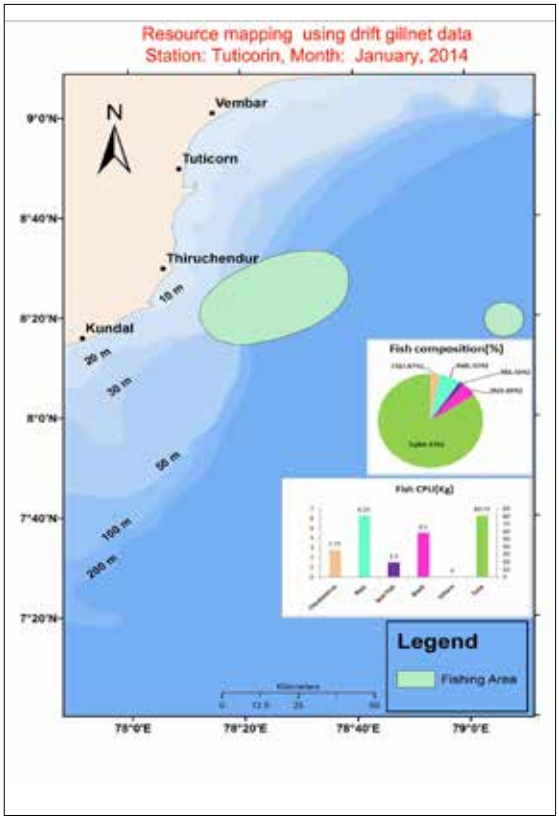
GIS inventory database with LandingGIS software support

Standardisation of protocols for resource mapping of gillnets, purseseines, ringseines and traditional gears

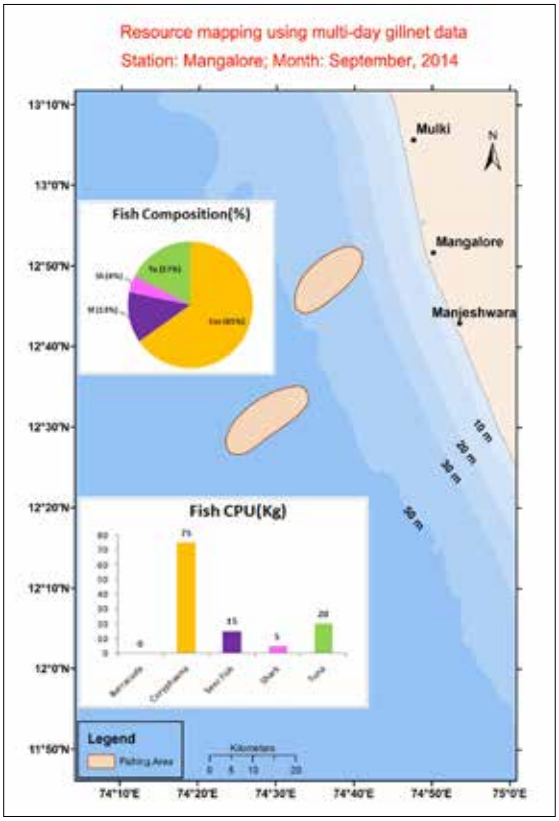
In 2013, the major thrust was on standardisation of protocols for resource mapping of data collected from trawlers. Based on the protocols, species, juvenile and spawner distribution of different species were projected. During 2014, the major thrust was given for developing protocols for resource mapping of gillnet, purseseine, ringseine and traditional gears. Protocols were standardised and are being used for mapping of resources caught from these gears in Tamil Nadu, Kerala and Karnataka. In Kerala, seasonal changes in the traditional gillnet fishery off Pallithode was used for standardising the resource mapping of single day gillnet units. Drift gillnet data from Tuticorin (Tamil Nadu) was mapped with species composition, abundance and spatial distribution of the species in different fishing grounds. In Karnataka, Multiday gillnetters, purseseine and ring seinedata were used for standardising the protocols for resource mapping.

Trawl foot print analysis in India

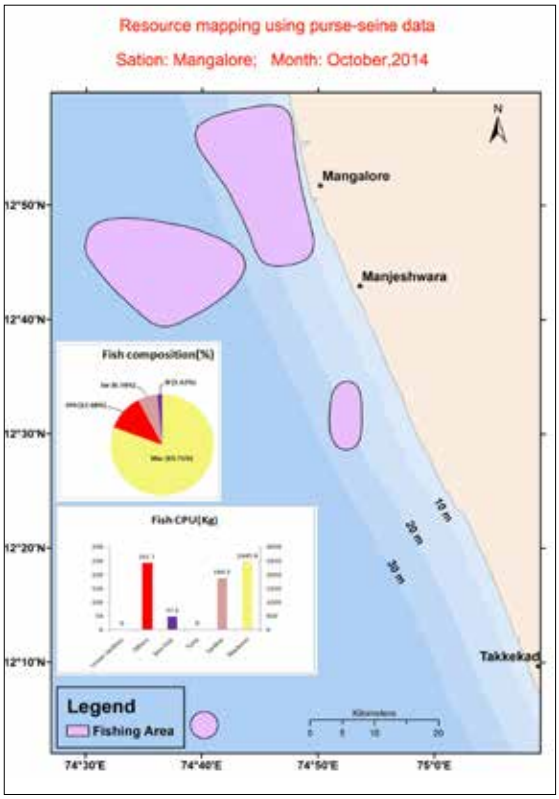
Globally trawl footprint studies are being used to identify the vulnerable marine ecosystems (VME) which will help to focus the fishing impact studies based on the critical nature of the fishing ground. With geo-spatial database, trawling footprint analysis was carried out at CMFRI, Mangalore, which is the maiden attempt on trawl foot print studies in Indian waters. Data from 1035 days commercial fishing information (2007 to 2013) were used. The database was strong enough to give illustrative information on fishing ground in day/month/season/year basis with operational maps. The area of the study was off Malabar and Konkan coast. The study showed that trawlers based at Mangalore operated from seas off Calicut in the south (75° E, 11°N) and off Ratnagiri in the north (73.5° E to 17° N)(fig.8), depth of operation being between 5 m and 167 m. The most intensive trawling operations were observed in fishing grounds at 30 m depth off Mangalore to Panaji, followed by fishing ground at 100 m depth off Malpe to Karwar. Fishing ground at 30 m depth off Ratnagiri was also found to be fished with moderate intensity. Areas within the existing trawling ground which was subjected to very high fishing pressure was identified, which will help focus on future study related to ecosystem and species vulnerability in these waters. These maps give a strong basis for participatory decision making on fishing effort reduction in terms of months and seasons, stressing upon specific resources very effectively.



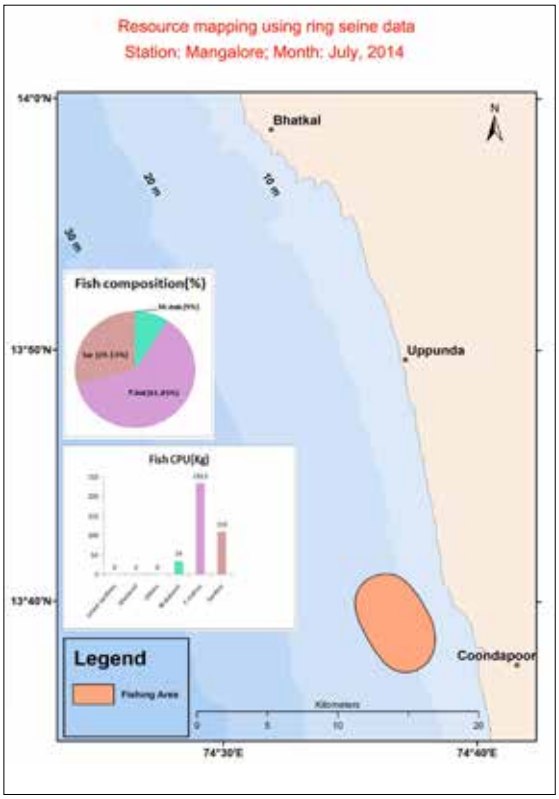
Resource mapping protocol developed for the data collected from drift gill net operation at Tuticorin, Tamil Nadu. Catch composition and Catch rate for the month is shown



Resource mapping protocol developed for the data collected from multiday gillnet operation at Mangalore. Catch composition and catch rate for the month is shown



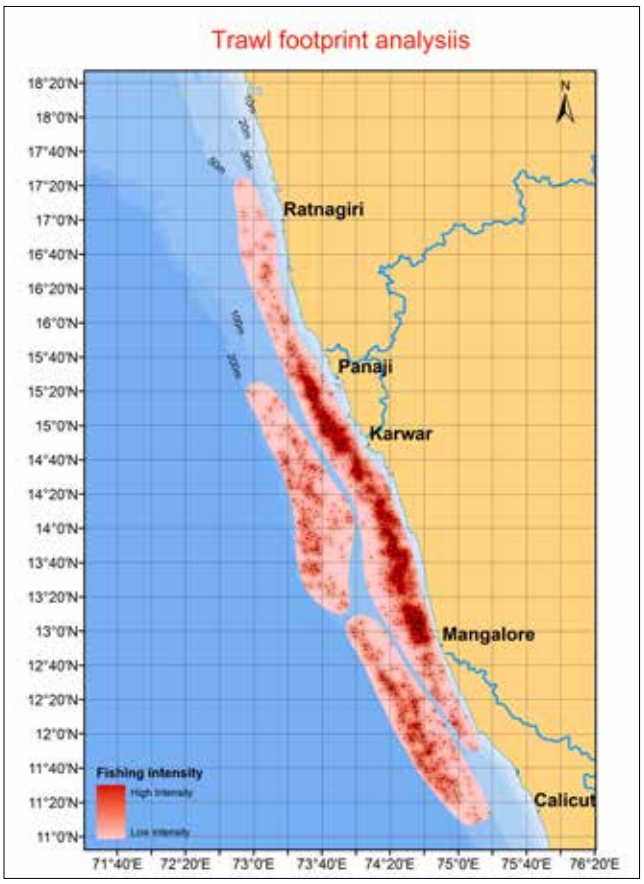
Resource mapping protocol developed for the data collected from purse seine operation at Mangalore. Catch composition and catch rate for the month is given.



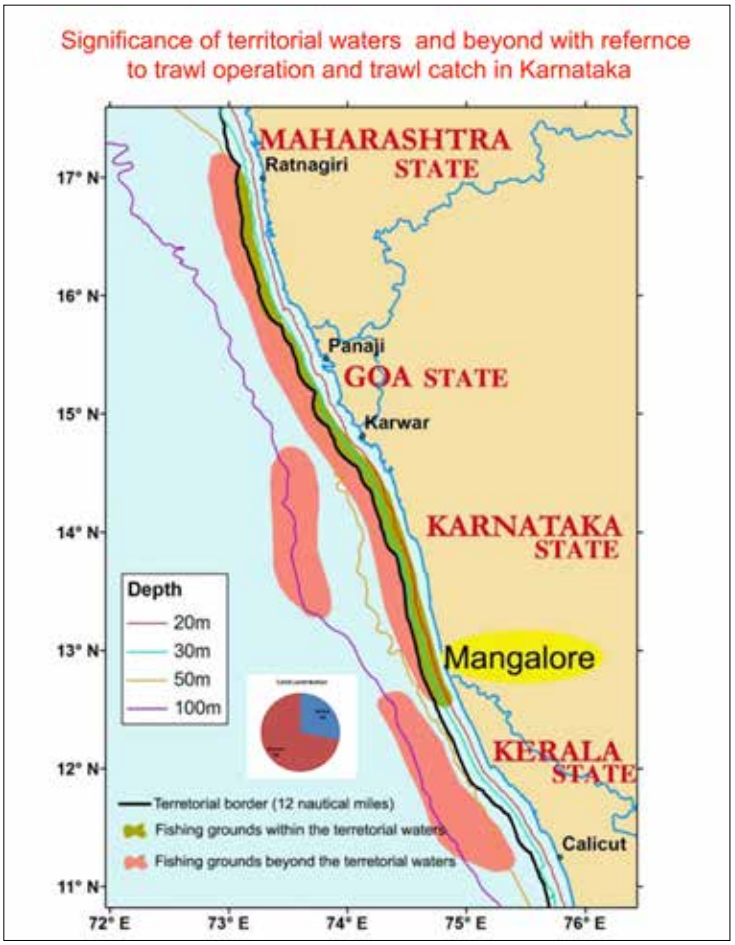
Resource mapping protocol developed for the data collected from ring seine operation at Mangalore. Catch composition and catch rate for the month is shown

Policy decision support for fisheries management

Highly dynamic nature of fishery makes fisheries jurisdiction and fisheries governance matter of concern in the fisheries sector. At present "the subject of fisheries" is in the "state list" under article 21 of the Indian Constitution. Management and control of coastal fisheries within the territorial waters is vested with the maritime Sates and Union Territories. Ever since trawling and other mechanised fishery extended beyond territorial waters, accusation of encroachment by fishing boats of neighbouring States in each other's territorial waters became a regular concern. In many cases it led to confiscation of boats and arresting of crews. A spatial study was initiated to understand changing pattern of fishing operations with geo-coded catch and effort data from trawlers. The present study, conducted along south-west coast of India clearly indicate that trawlers from Karnataka operate in the waters off adjacent states Kerala, Goa and Maharashtra, which is the case with almost all multiday trawlers that operate from different states. As far as fish catch by trawlers are concerned, it was estimated that in Karnataka more than 70% of the catch was brought from the waters beyond 12 nautical miles, from Indian EEZ. On the basis of this dynamic fishing pattern, the fishing regulatory decisions should be taken up at a regional level and beyond territorial waters. The rights of fishermen from all the states should be decided by a governing body with all concerned States and Union Territories. To bring all fishery operations under a single management umbrella, a regional fishery regulatory body under the auspices of Central Government is extremely essential. Further spatial studies of catch and effort from the mechanised vessels



Trawl foot print analysis of geocoded data from the trawling ground off Malabar and Konkan coast for vulnerably assessment studies of ecosystem.



Mapping of fishing ground information and catch data to find out the changing pattern of trawling in recent years, which necessitates policy changes.

operated from different States and Union Territories need to be undertaken to understand National scenario of the changing fishing pattern in India.

Artificial Neural Network (ANN) models

Research project: FISHCMFRISIL201200100001

- Artificial neural network (ANN) models were developed for predicting the marine fish landings of north-east coast. The method is based on training an ANN with auto regression using input data on quarter-wise marine fish landings during 1985-2013. The landings for the future years were estimated using the trained ANN with the current set of data. A total of 20 networks were fitted, each with random starting weights. The network is trained for one-step forecasting. The fitted model is a feed-forward network NNAR(13,7,1) with 13 lagged inputs and one hidden layer with seven neurons. Multi-step forecasts for next ten years were computed recursively. The resulting model corresponds well to observed values.

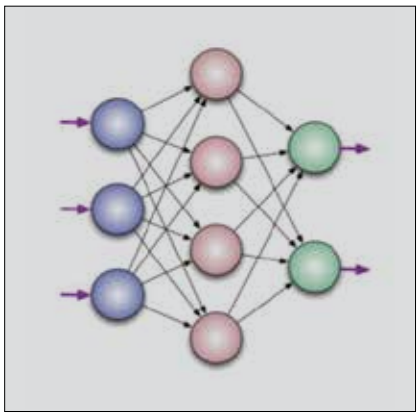
- ARIMA and Neural Networks models were fitted and evaluated using monthly estimates of oil sardine landings from Kerala during 1992-2013. The measures of accuracy were computed and compared for the original time series and the fitted models. Among ARIMA models, ARIMA(3,0,1)(2,1,1)12 was found to be the best suitable model. In the case of Neural Network models, feed-forward network having one hidden layer with 17

lagged inputs and 9 nodes was identified as the most appropriate model for predicting monthly oil sardine landings. ARIMA and Neural Networks were assessed on the basis of their efficiency to provide accurate fits and predictions. The results reveal that NNAR(17,9) model is the best performer, characterized by a higher number of stable forecasts and forecasts with higher precision and accuracy, than the ARIMA model.

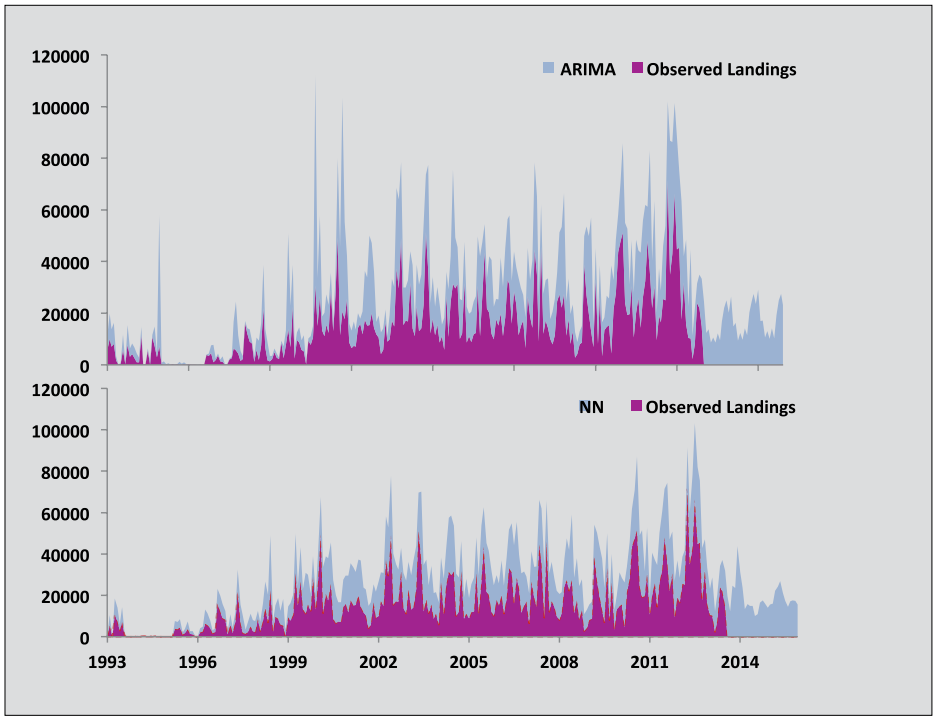
Vulnerability of resources to climate change in hotspot regions

Research Project: EF-5/GULLS

The effect of climatic variation on the fishery along the coastal districts of south Kerala was evaluated through Dynamic Factor Analysis (DFA). Historic multivariate time series data on marine fish landings per hour (LPH) for major 10 resources namely oil sardine, threadfin breams, Indian mackerel, stolephorus, cephalopos, scads, penaeid prawns, ribbonfish, other carangids and lizard fish, which accounted for more than 80% of the landings in the region, were used as response variables in DFA model and climatic variables such as sea surface temperature, air temperature, sea level pressure, zonal wind in WE direction, Merideonal wind in NS direction and scalar wind intensity were used as explanatory variables. Results showed that increase in sea surface temperature adversely affect threadfin breams stock, increase in zonal wind (WE



Neural network with input and output layers



Forecasts using ARIMA and Neural network models

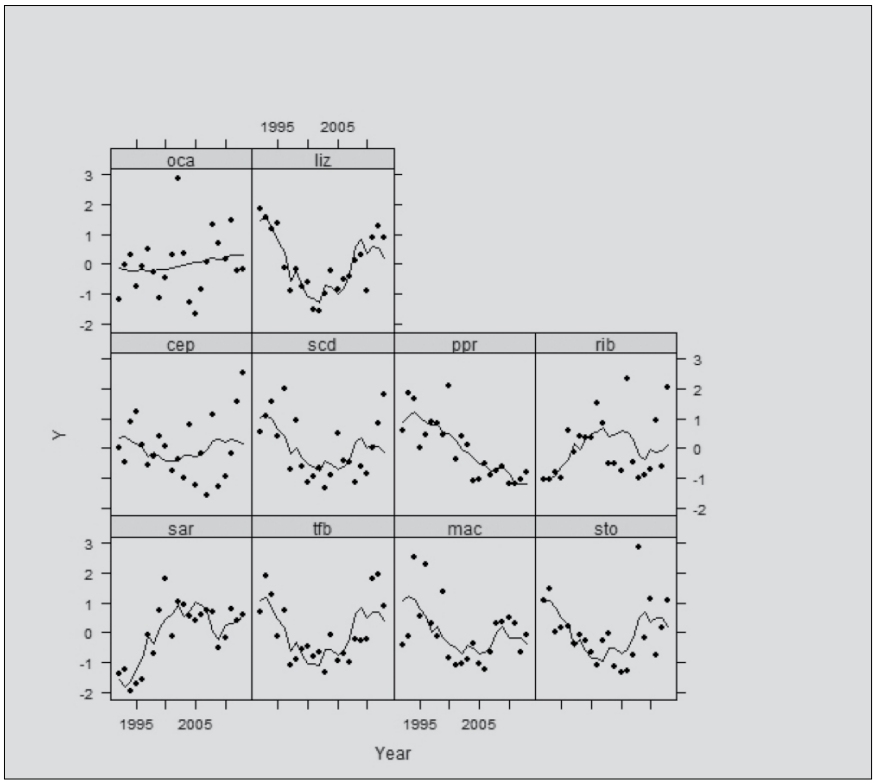
direction) is beneficial to stocks of stolephorus sp. and lizard fish whereas increase in scalar wind intensity adversely affect both these stocks.

Chlorophyll based Remote-sensing Assisted Forecasting System (ChloRIFFS)

Research project: FISHCMFRISIL201200200002

Datasheets used in the estimation of marine fish landings have been reprocessed at all regional stations for geo-referencing. A self-adjusting robust passive georeferencing algorithm was developed to trace out the origin of most possible fishing ground for resources landed in a center, using the auxiliary data such as distance and direction of boat trip etc. which was validated with the survey data. The algorithm was applied to georeference historic data of major centers such as Veraval, Visakhapatnam, Tuticorin and Mangalore since 2006. Hydro-biological parameters for the designated nine grids for North west (1, 2 & 3) and South west (4 & 5), North east (8 & 9), South east (6 & 7) region were collected covering depth ranges from 10-40 m.

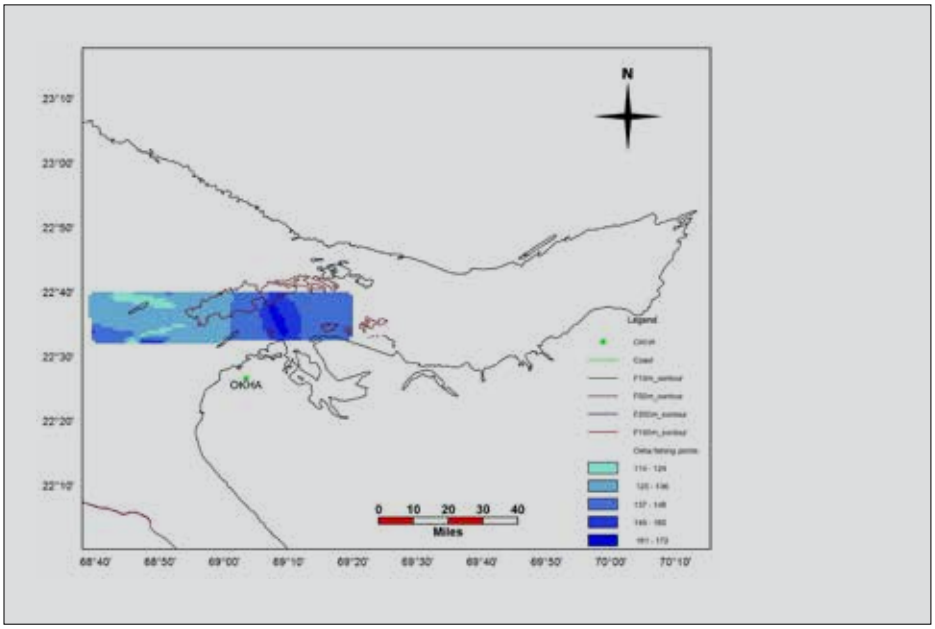
For estimating higher order animal biomass, foraging/feeding and niche based prediction models were used. Two specific models using Reaction



Observed and fitted values for LPUE of different marine fishery resources in the south Kerala coast using Dynamic Factor Analysis model

Transport diffusion modeling approach were developed for three resources viz. Oil sardine (small pelagic), Kawa kawa (Migratory pelagic) and Threadfin breams (Demersal). Their predicted spots of availability during the period December2014 - January2015 was tracked using Quantum GIS software with inputs from the Trans Act model.

For a one-dimensional concision of the catch-rate of gears, landed



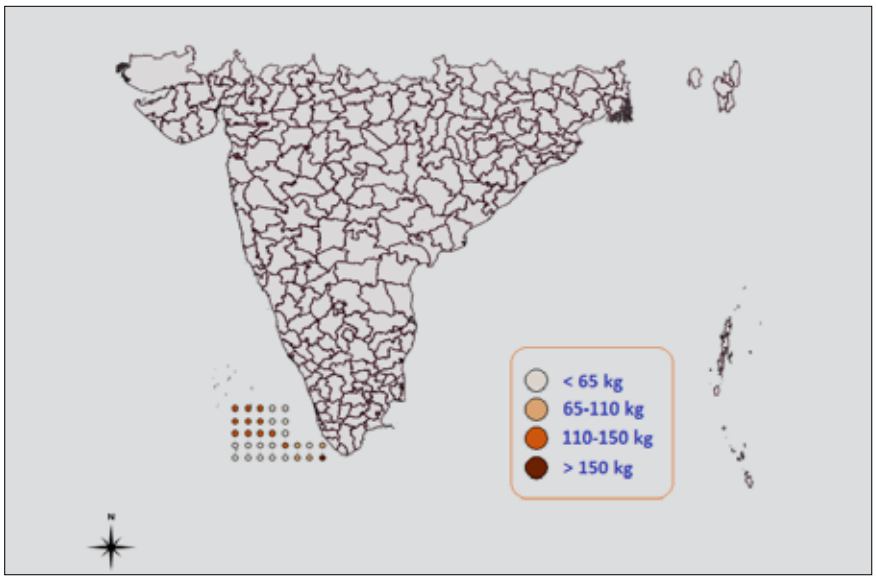
The interpolated fishing intensity plot of fishing grounds off Okha, Gujarat

Habitat based modeling

For resource *X*, *r* is the shift rate, *x* and *y* are the spatial coordinates and Y is the prey of X

$$\frac{\partial X}{\partial Y} = r\,(x,y)X\,(1-X) - \frac{aX}{1+bX}\,Y + d\Delta X$$

quantity and effort quantity, a new parameter named Index of Relative Prominence of resources was proposed and computed for the three resources. New attempts have been initiated to suitably modify the common optical algorithms used in remote sensing based assessment of Net Primary Productivity (NPP) whereby exogenous factors could be incorporated at the tertiary level. An attempt was made using a combination of R software and SeaDAS. interface on Chl-a data.



The predicted Threadfin breams potential off SW coast of Indian EEZ during Dec14-Jan 2015 based on simulated diffusion models using environmental and fishery data of 2011-13

Application of Remote Sensing for modeling marine fisheries ecosystem

Research project: EF-35/DST-JNSF

Delineation of the Ecological Provinces in the Indian Ocean

Monthly composite satellite derived datasets on Remote sensing reflectance (R_{RS}) have been obtained from Ocean Colour Climate Change Initiative (OC-CCI). Sample datasets are being used to classify the Indian Ocean based on fuzzy c-mean clustering algorithm in R software. Cluster validity analysis such as Xie - beni index and Partition coefficient were followed to decide on optimal cluster numbers (classes) to be preferred for the classification of the study area. Initially, five optical classes were determined and plotted in Indian Ocean map. Mean and standard deviation reflectance range of each optical class was plotted to understand the variations in the wavelength R_{RS} domain covered by mean classes and their corresponding standard deviation.

Oil sardine feeding behavior and inter-annual fluctuation of stock

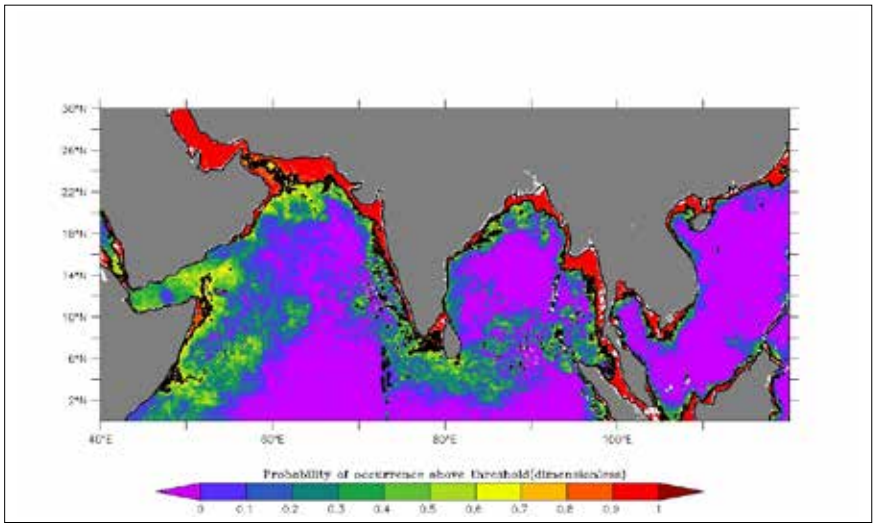
The inter-annual fluctuations of sardine stock are being characterised. Annual oil sardine landings data were used to find the relationship of fluctuations in landings with climate indices. Maps of chlorophyll persistence were plotted to assess the persistence areas that correspond to regions where high sardine landings are recorded. The persistence maps for May-September were plotted as this corresponds to the time period when sardines are actively caught from the Indian shores. As sardines are only caught from a maximum depth of 200 m, a 200 m depth contour has been plotted in the Northern Indian Ocean to identify the regions from which the sardines are caught. Also for 75% chlorophyll persistence, another line is being plotted on the existing persistence map in order to evaluate the change in high chlorophyll persistence regions from year to year.

Study on relationship between distributions of phytoplankton and marine aerosols

Daily and monthly chlorophyll satellite datasets downloaded for the period from 1998 to 2010. An area averaged time series of chlorophyll-a and Aerosol Optical Thickness (AOT) from SeaWiFS has been plotted for January 1998 to December 2010. Correlation maps are being plotted in between OC-CCI chlorophyll-a and SeaWifs AOT data to study the relationship between phytoplankton distribution and marine aerosols. The initial results show both positive and negative correlations. Correlation map for significant correlation is in progress.

Modification of EMPOWER 1.0 to suit the Indian Ocean

EMPOWER 1.0 is a simulation model of the marine ecosystem. Work is currently underway using a duplication model as a learning tool for the original model. New production and P growth are being calculated using the



Map of chlorophyll-a above threshold of 0.3 mg m^{-3} persistence in the Northern Indian Ocean for April-September 1998 using OC-CCI data overlaid by 0.75 persistence contour.

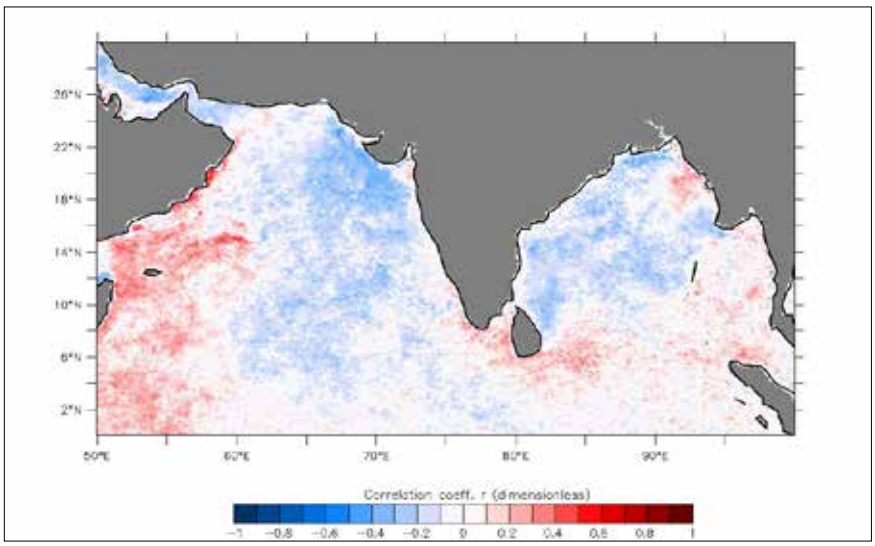
model. The model is being tuned using parameters from the Indian Ocean, for estimating the new production in the Indian Ocean using remotely sensed data.

Prediction of recruitment success in major Indian marine fish stocks

Research Project: EF-9/ MoES

Eggs, larvae and juveniles of teleosts collected from different depth regions were documented.

Bloom - Main food for maturing population and newly recruited population of sardines. Blooms of 9 species of diatoms *viz. Fragilaria oceanica, Skeletonema costatum, Thalassiosira subtilis, Chaetoceros affinis, Chaetoceros compressus, Melosira sulcata, Leptocylindrus minimus, Guinardia flaccida,* and *Bacteria strumhyalinum* occurred in the 5 to 30 m depth zone during the period 2013-2014.



Correlation map between monthly OC-CCI Chlorophyll-a and SeaWiFS AOT during 1998-2010

Ecological modelling of the epipelagic habitat off Kerala and Lakshadweep

Evaluating biological security of PFZ advisories

Occurrence of main spawning biomass of major fishes and their relative occurrence in PFZ area were checked by observing the biology of the major species in the catch. During the reporting period, PFZ advisories were released by INCOIS from October to March. From May to September, there were no advisories due to bad weather and other technical factors. Analysis of maturity stages of commercially important fishes which are caught in the PFZ zones indicated that these are not the major spawning areas and that the advisories are not a threat to fishing of spawning biomass.

Percentage occurrence of PFZ advisories in different fishing areas of Kerala

Month & Year	South of Muttom	Muttom -Kollam	Kovilthottam - Vypin	Munambam - Ponnani	Purattur - Kannur	Kannur-Kumbla
Jan-14	6	20	15	24	17	17
Feb-14	9	24	7	9	27	24
Mar-14		33	23	14	22	8
Apr-14	1	28	25	22	19	6
Oct-14	1	23	23	19	27	5
Nov-14	2	26	39	17	15	2
Dec-14	1	21	22	18	25	14
Jan-15	1	34	22	14	25	5
Feb-15		44	25	10	15	6

Percentage occurrence of PFZ in different ecological regions off Kerala

Month	Nearshore <50 m	Mid Continental Shelf 50-200 m	Continental slope >200 m
Jan-14	31.79	23.84	44.37
Feb-14	39.61	22.73	37.66
Mar-14	43.09	20.33	36.59
Apr-14		17.65	32.35
Oct-14	46.05	28.95	25.00
Nov-14	33.71	29.71	36.57
Dec-14	15.86	26.43	57.71
Jan-15	47.47	17.72	34.81
Feb-15	19.48	27.27	53.25

ECOPATH modelling of Pelagic Ecosystem of Kerala

The basic inputs required for ECOPATH modelling pertaining to the study area was collated and preliminary estimates were made. The study area was estimated as 34500 km^2 including the continental shelf area. The catch of the major resources for the period 2011 to 2013, basic inputs such as Length Infinity (L_∞), Weight Infinity (W_∞), stomach content data and diet of the resources

and other biological parameters of 128 species were collated. Weight Infinity (g), Production/Biomass P/B(Z), Consumption/biomass (Q/B) and Biomass (t km^{-2}) of 17 groups such as pelagic sharks, large pelagics, tunas (coastal and oceanic), oilsardine, other clupeids, Indian mackerel, anchovies, pelagic omnivores, medium bentho pelagics, ribbonfishes, small bentho pelagics, billfishes, pelagic crabs, cephalopods, benthic shrimps, small benthic omnivores and benthic carnivores were estimated.

Basic estimates calculated for the selected fishery groups along Kerala coast for Ecopath modelling

GROUPS	W∞ (g)	P/B(Z)	Q/B	Biomass (t km^{-2})
Pelagic sharks	12514.9	2.38125	7.575	0.006312958
Large pelagics	16967.94	3.275	9.58125	0.076280022
Tunas (coastal and oceanic)	9735.33	2.906667	15.16111	0.405428159
Oil sardine	51.0441	2.23	77.4	10.06420776
Other clupeids	74.342	7.6754	61.94	0.316976443
Indian mackerel	346.6078	6.34	62.8	0.340342605
Anchovies	10.24509	3	38.125	0.082794102
Pelagic omnivores	4855.3	2.33	13.84	0.000286274
Medium bentho pelagics	1972.395	2.775	15.73	0.039951882
Ribbonfishes	2528.245	2.44	11.82667	1.956980411
Small bentho pelagics	821.2792	3.744286	22.242	0.545290069
Billfishes	61476.57	1.8	9.13	0.404949469
Pelagic crabs	515.7475	4.5925	8.5	0.016129708
Cephalopods	137.5687	3.88	36.5	0.006312958
Benthic shrimp	24.56489	7.814375	19.2	0.162670017
Small benthic omnivore	36.03016	5.645	33.45571	0.040957278
Benthic carnivore	720.4299	4.055	11.095	0.082214209

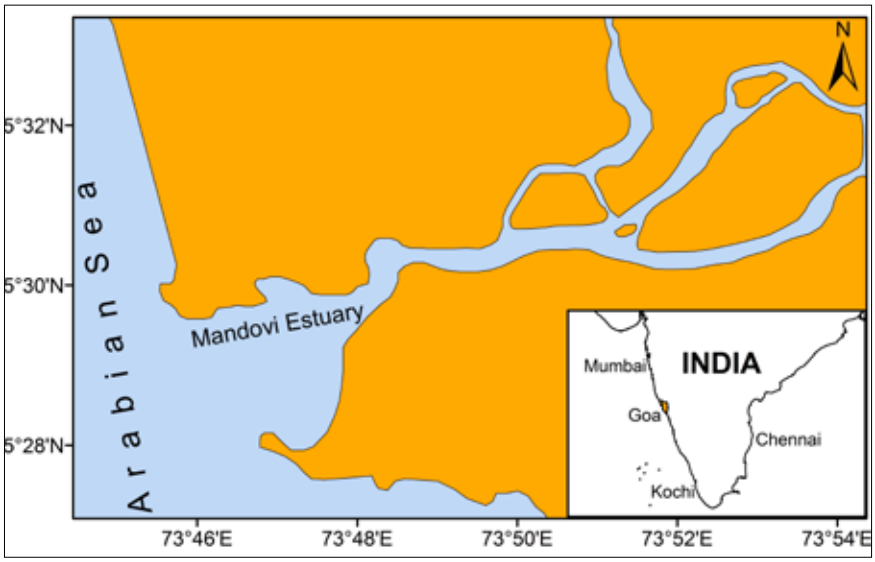
Validation of advisories in Lakshadweep waters

The tuna advisories were validated through catch observation of landings at Minicoy, Agathi and Androth. Perumalpara Reef, Kavarati, Cheriyakara and Kalpeni which occurred more frequently as PFZ. Experimental fishing was carried out thrice in January, February and March. However, the catch was very low. Zooplankton was collected and analysed. Seasonal variation was observed in the zooplankton community.

Flow of matter through trophic levels and biogeochemical cycles in marine and estuarine ecosystems

Research Project: EF-16/MoES

Preliminary Mass-balance Ecopath Model was done in the Mandovi Estuary, Goa during the period. The species in the estuary were grouped into 15 ecological groups including the detritus. Input parameters (biomass, P/B and Q/B ratios, diet matrix and fishery information) were estimated and entered in the basic input sheets and ecopath parametrization was done. The total system throughput estimated for Mandovi estuarine ecosystem was 4712.19

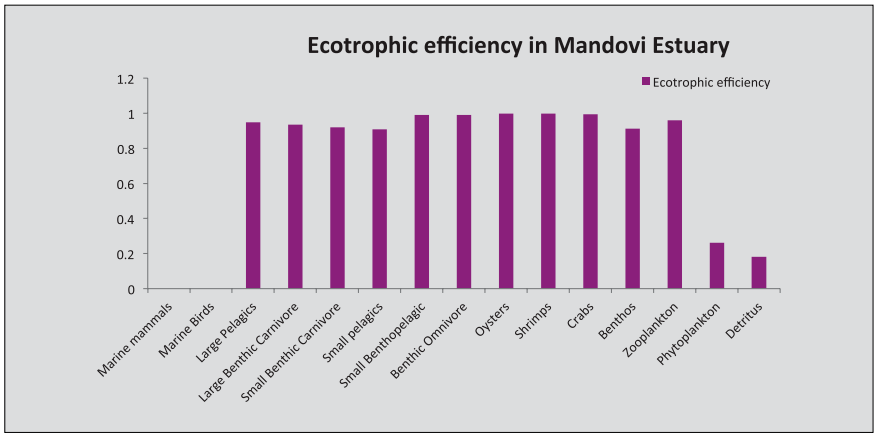


Location of Mandovi Estuary

t km-2 year-1, which is comparable with other estuarine ecosystems.

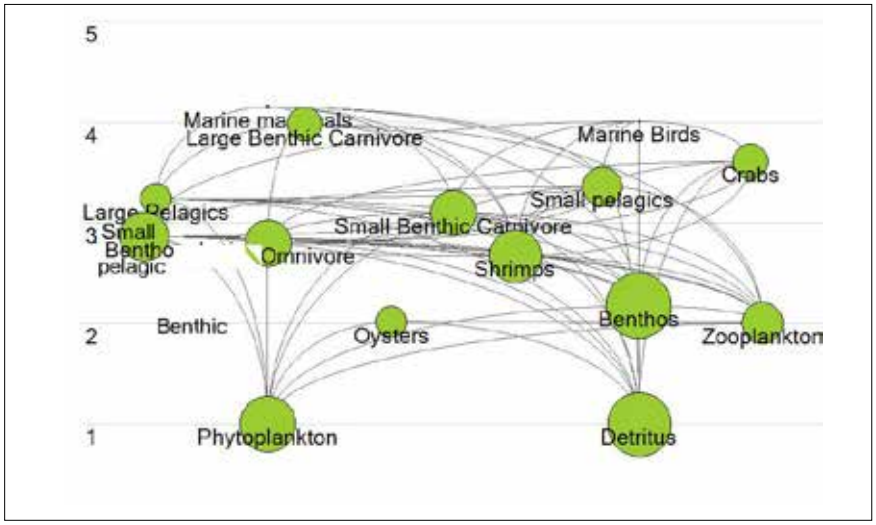
Fishery in the Mandovi estuarine ecosystem had a mean trophic level of 2.95 with the minimum being 1 (phytoplankton) and maximum being 4.15 (marine mammals).

In Mandovi Estuary the ecotrophic efficiency (EE) of most of the ecological groups except that of marine mammals, birds, large pelagics and large benthic carnivores is near to 1 indicating that the groups are highly preyed



upon or fished. The high EE of detritus indicates that significant quantity of detritus is going into the system than being buried into the detritus.

The total primary production/total respiration ratio of 1.174 implies that the Mandovi estuarine ecosystem is in developing stage with its ratio greater



Flow diagram of trophic interaction in Mandovi Estuary

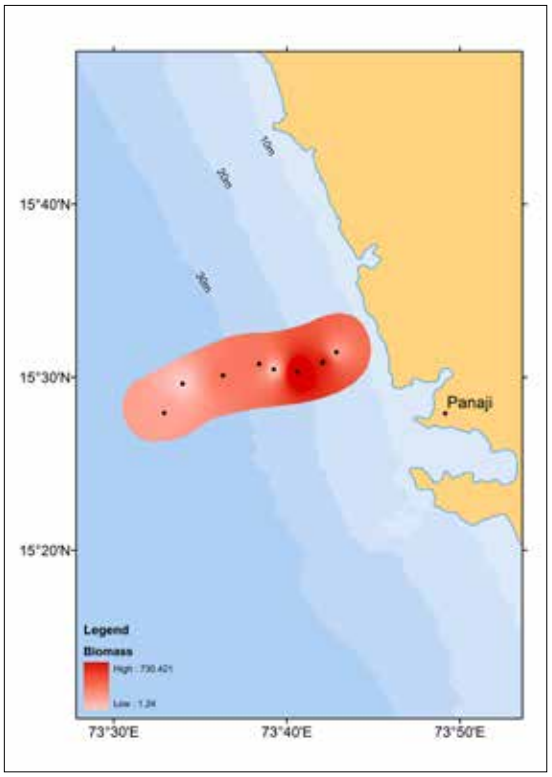
than 1. The net system production value of 205 t km-^{2} year-1 obtained for Mandovi estuarine ecosystem again indicates the developing nature of the ecosystem.

System omnivory index (OI) of 0.33 is obtained in the Mandovi Estuary, indicating consumer feeding on different trophic levels. The maximum OI was observed for large pelagics followed by benthic omnivores and small benthopelagics.

The flows to detritus were maximum for zooplankton followed by benthos and phytoplankton. The least flows were observed for apex predators.

Maximum prey overlap was for group 10 (shrimps). Group 7 (small benthopelagics), group 8 (benthic omnivores) and group 12 (benthos) also showed significant prey overlap. Maximum primary production required for harvest of groups was observed for group 5 (benthic carnivores), group 7 (small benthopealgics) and group 10 (shrimps). The maximum primary production required for consumption of groups was observed for lower trophic level groups viz., zooplankton and benthos.

Experimental trawling was done in coastal waters of Goa for biomass estimation. About 49 species were present in the trawling area. The highest biomass was estimated in the month of January and lowest during September –October.



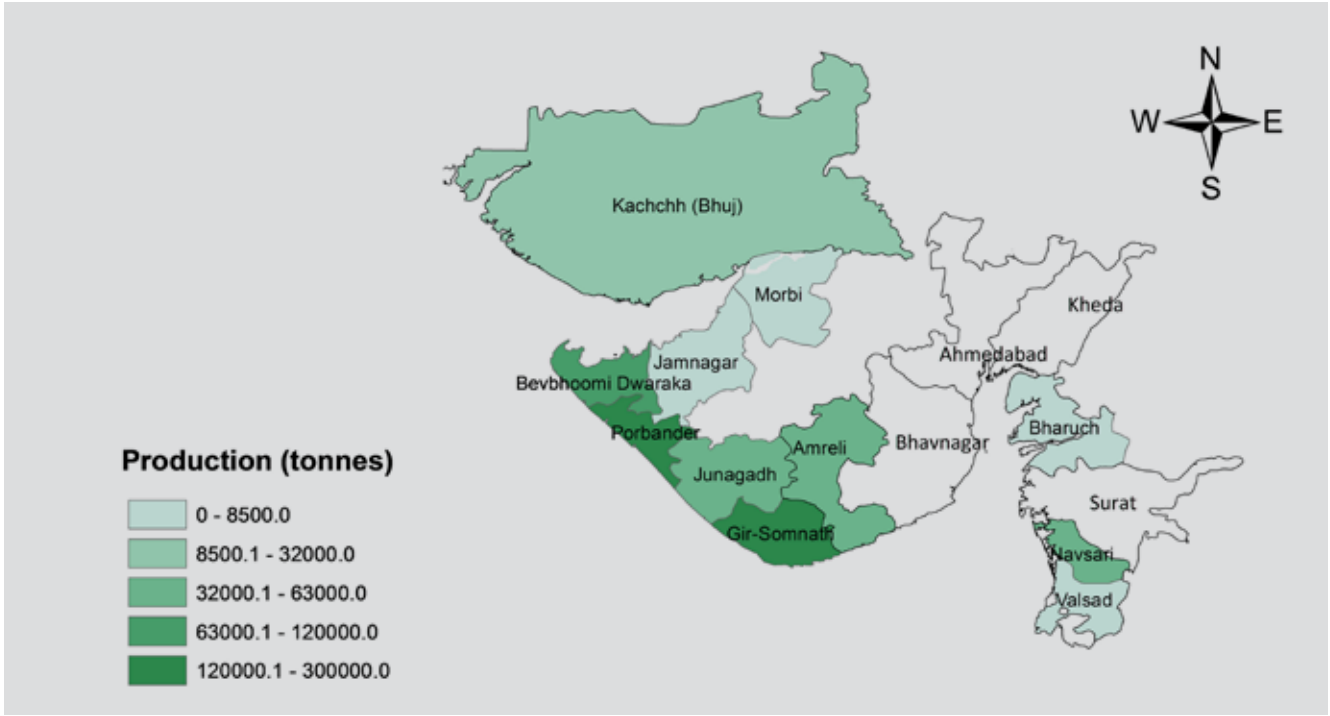
Map showing experimental trawling points along with the biomass abundance

SUSTAINABLE MANAGEMENT OF FISHERY RESOURCES

Gujarat

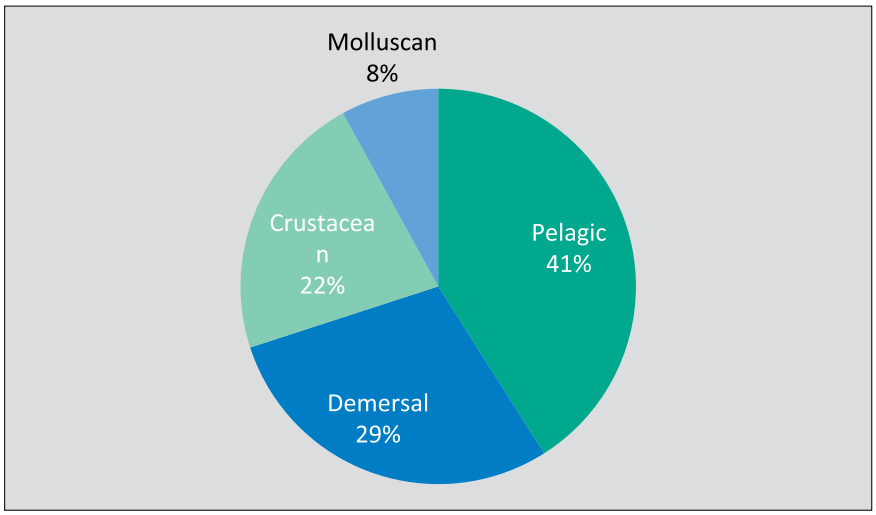
Research Project: FISHCMFRISIL201200400004

During 2014, annual marine fish landings of Gujarat was 7.12 lakh t. Landings showed slight decrease in comparison with previous year (7.17 lakh t). In district-wise production Gir-Somnath ranked first with 2.95 lakh t followed by Porbandar (1.20 lakh t), Dev Bhoomi Dwaraka (1.08 lakh t), Amreli (0.63 lakh t), Junagadh (0.56 lakh t), Navsari (0.32 lakh t), Kutch (0.27 lakh t), Valsad (0.08 lakh t), Baruch (94 t) and Morbi (72 t). Pelagic finfish resources contributed maximum (41%), followed by demersals (29%), crustaceans (22%) and molluscan resources (8%). Prominent groups which contributed to the total landings were non-penaeid shrimps (15.05%), ribbonfishes (14.26%), Bombayduck (9.43%), croakers (7.78%), penaeid shrimps (5.10%), threadfin breams (4.65%), cuttlefish (4.10%), catfishes (3.92%) and squids (3.88%).



District-wise marine fish landings of Gujarat-2014

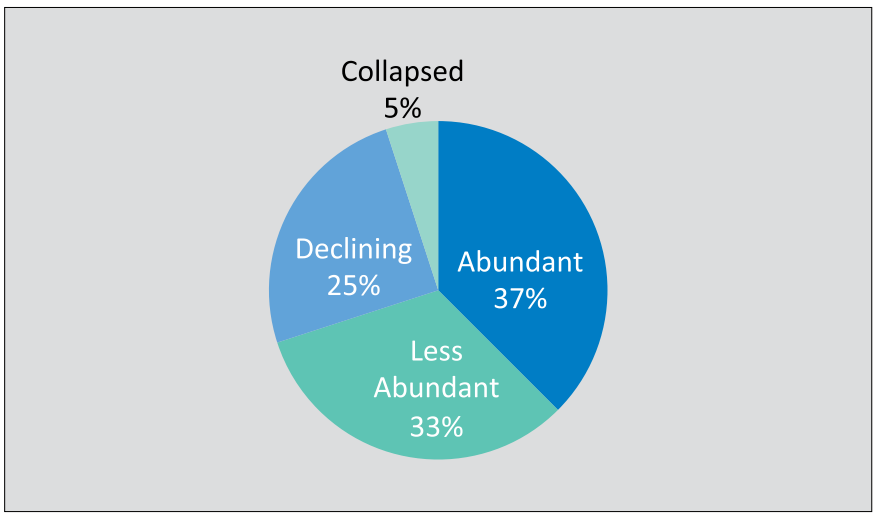
Sector-wise contribution showed dominance of mechanised vessels with a catch of 6.12 lakh t followed by motorised (0.99 lakh t) and non-motorised vessels. Trawlnets contributed 54.27% of the annual fish landings, followed by other gears like dolnets (27.67%), gillnets (16.12%) and others (1.95%). Catch per unit effort, CPUE (units) was maximum in multiday trawlnets (3.67 t) while CPUE (in fishing hours) was highest in single day trawlnets (82.0 kg).



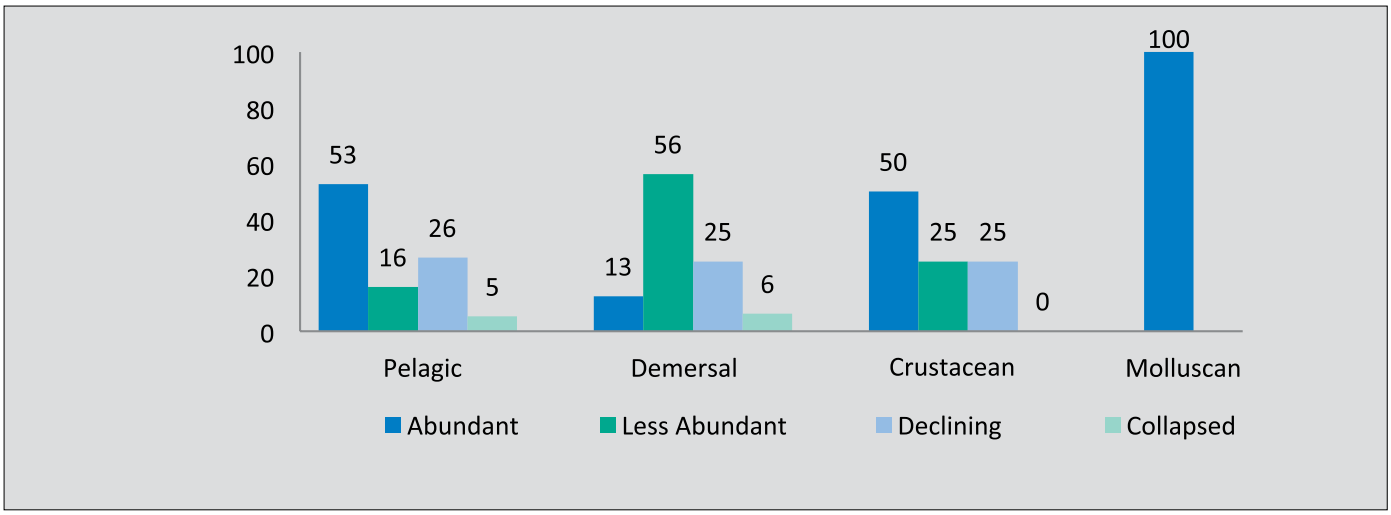
Resource-wise marine fish landings of Gujarat -2014

Rapid stock assessment of marine fish stocks

Stock status of important marine fish resources of Gujarat were studied using rapid stock assessment method. Forty commercially important groups/ stocks were analysed, of which 37% of stocks were in the abundant category, 33% were less abundant, 25% were declining and 5% had reached collapsed phase. Out of 19 pelagic groups, 53% were in the abundant phase, 16% were less abundant, 26% were declining, and 5% in the collapsed stage. Among pelagic stocks, unicorn cod was in the collapsed status. Among the 16 demersal groups, 13% were abundant, 56% less abundant, 25% declining, and 6% in the collapsed state. Among demersals, white fish (big-jawed jumper) was in the collapsed phase. Among crustacean resources



Stock status of important marine fishery resources



Group-wise status of marine fish stocks

50% were abundant, 25% less abundant and 25% in declining (crabs and lobsters) status. Among molluscan resources, only cephalopod status was studied and this resource was abundant.

Pelagic resources

Pelagic fishes with a landing of 2.91 lakh t formed nearly 41% of the total marine fish landings in Gujarat during 2014. The major resources under this category were ribbonfish followed by Bombayduck, clupeids, seerfishes, carangids and tunnies. Mechanised dolnet is the major gear targeting Bombayduck contributing nearly 90% of the landing followed by outboard dolnetters (5.2%). Mechanised multiday trawlers alone contributed 85.4% of the total ribbonfish landing with a catch rate of 958 kg per unit and the remaining by mechanied dolnetters (8.7%), single day trawlers (4%) and gillnetters (1.9%). Outboard gillnetters (59%) and mechanised multiday gillnetters (34%) were the major gears which contributed to the fishery. Dominant species landed were *Thunnus tonggol* (42.5%), *Euthynnus affinis* (38.4%), *Auxis* sp. (2.8%), *Katsuwonus pelamis* (4.1%) and other tunas like *Thunnus albacares* and *Sarda orientalis* (12.3%). Among carangids, *Megalaspis cordyla* formed 34.6% of the total carangid landings mainly in gears like trawls and gillnets, with outboard gillnet contributing 62.4% and multiday trawlnets forming 30.7%. *Decapterus russelli* (13%) formed the next major species among the *carangids* and trawlers landed almost entire (99.9%) catch. Leatherbacks constituted 25.4% and all other carangids constituted 27%. The outboard gillnetters (42.9%), multiday trawlers (38.2%) and multiday gillnetters (18%) landed the leatherbacks. Nearly 79% of the mackerel landing was contributed by outboard gillnetters and 18% by the mechanised multiday trawlers. Seerfish fishery mainly comprised of *Scomberomorus commerson* (51.4%) and *Scomberomorus guttatus* (48.6%). Outboard gillnetters contributed 63.4% of the catch and the other major gears were multiday gillneters (14%) and multiday trawlers (14%). Among clupeids, major species/groups in the fishery were the *Chirocentrus dorab* (19.4%), *Coilia dussumieri* (19%), *Thryssa* sp. (18.7%), oilsardine (18.2%), other cluepids (13.9%), *Hilsa ilisha* (3.2%) and other shads (4.4%). Major gears landing clupeids were outboard gillnetters (26.4%), mechanised multiday trawlers (23.2%), other outboard fitted crafts (22.7%) and mechanised dolnetters (17.9%). Mechanised dolnetters (61.7%) caught *Coilia dussumieri* while the outboard gillnetters (60%) mainly caught the wolf herring.

Striped spanish mackerel landed at Vanakbara Landing Centre, Diu

Demersal resources

Demersal landings were estimated as 2.06 lakh t (1.03% decrease from previous year) which formed 29% of total production. Croakers (27.01%) formed the highest catch followed by threadfin breams (16.14%), catfishes (13.58%), soles (6.22%) and lizardfishes (5.38%). Sector-wise contribution of demersal fish landings of Gujarat showed that multiday trawlers contributed 62.1% followed by multiday gillnetters (14.2%) and outboard gillnetters (11.7%).

Among the major demersal resources, croakers (27.01%) formed the highest catch followed by threadfin breams (16.14%), catfishes (13.58%), soles (6.22%), and lizardfishes (5.38%). Almost all the major resources recorded positive growth from 2013. Threadfin breams were landed by mechanised trawlers alone and the major species in the landings were *Nemipterus japonicus* (52%) and *Nemipterus randalli* (48%). Sciaenids were landed mainly by mechanised trawlers (65.83%) followed by dolnets (30.98%) and gillnets (3.17%). Dominant sciaenid species in the trawl fishery were *Otolithes cuvieri* (49.87%), *Johnieops sina* (26.32%), *Johnius glaucus* (18.46%), *Otolithoides biauritus* (3.21%), *Otolithes ruber* (1.38%) and *Protonibea diacanthus* (0.74%). Pomfret fishery of Gujarat was mainly constituted by silver pomfret (65.56%) and black pomfret (34.43%). Catch of silver pomfret contributed 4.05% to the total demersal landing. Landing of silver pomfret was mainly from trawl (56.01%) followed by dolnet (23.36%) and gillnet (19.61%). The landing of black pomfret was mainly by mechanised trawl (65.98%) followed by gillnet (21.48%) and dolnet (13.52%). The catfish landing was mainly by trawlnet (54.28 %) followed by dolnet (36.04%) and gillnet (9.67%). The estimated lizardfish landing was 11,045 t forming 5.4% of total demersal landing which comprised of *Saurida tumbil* (54.09%) and *Saurida undosquamis* (45.90%) landed by trawl alone.

Among elasmobranch resouces sharks formed 70% (8016 t), followed by rays (2167 t, 19%) and skates (1308 t, 11%). Sharks were exploited by outboard gillnetters (31%), mechanised gillnetters (31%) and multiday trawlers (27%). Mechanised dolnetters (6%) and hook and line (4%) also contributed to shark landings. Multiday trawlers (79%), mechanised gillnetters (10%), outboard gillnetters (7%) and hook & line (4%) exploited skates. Rays were exploited by multiday trawlers (46%), mechanised gillnetters (26%), outboard gillnetters (12%) and mechanised dolnetters (11%).

Biology of major marine finfish resources landed along Gujarat in 2014

Species	Length range (mm)	Mean length (mm)	Sex ratio (M:F)	Fecundity	Ova diameter (µm)	% maturity	IRI (Highest)
H. nehereus	109-359	222.6	1.6	27,933	810	29.5	shrimps
T. lepturus	400-1139	650.5	1.5	22,633	906	48.5	Shrimps
T. tongol	300-819	573.3	2	11,90,318	-	25	fish
E. affinis	300-699	513.8	2.4	4,34,227	-	47.4	fish
M. cordyla	160-459	324.2	2.2	2,12,218	517	44.7	Shrimps
R. kanagurta	140-269	236	2.6	44,754	1193	76	plankton
S. guttatus	200-669	433.55		73,940	865	71.4	
C. dussumieri	90-209	163.7	0.7	4,489	633	56.8	shrimps
N. japonicus	131-398	223.69	2.14	72,186	395	36.65	shrimps
N. randalli	113-315	200.28	3.94	26,091	368	45.5	shrimps
O.cuvierii	110-366	250.96	1.86	1,12,523	342	52.12	shrimps
J. glaucus	111-300	209.34	2.80	71,654	440	87.95	shrimps
S. tumbil	100-490	292.44	3.02	91,389	531	38.12	fish
S. undosquamis	100-400	247.42	2.87	84,802	445	54.95	fish
P. hamrur	140-355	248.77	1.90	1,12,249	261	52.45	prawns
M. bagio	459-1135	750.18	1.78	2,33,389	610	48	fish
P. argenteus	95-339	128.08	1.08	44,650	429	30.90	plankton
P. niger	100-372	187.39	3.69	65,042	310	32	plankton
P. tenuispinis	201-970	421.73	2.64	538	840	40.74	Shrimp
S. laticaudus	260-631	462.08	1.29	2-14	-	78	fish

Biological reference points (BRPs) for the important marine finfish resources landed in Gujarat

Major spp.	Ecur	Y_{cur} (t)	Y_{cur} (million ₹.)	F_{msy} (%)	F_{mey} (%)	$B_{0.5}$ (%)	$SSB_{0.20}$ (%)
Euthynnus affinis	0.35	7802	113777	300	300	300	300
Trichiurus lepturus	0.56	11550	433000	220	120	80	100
Megalaspis cordyla	0.38	117400	226000	220	180	160	240
Coryphaena hippurus	0.26	40301	3436584	300	300	300	300
Nemipterus japonicus	0.66	14777	27635	70	40	30	40
Johnius glaucus	0.70	23640	102628	120	80	40	80
Plicofollis (=Arius) tenuispinis	0.75	9966	25169	80	200	20	80
Pampus argenteus	0.51	7985	113000	60	40	40	80
Scoliodon laticaudus	0.45	11304	71854	80	60	100	80

Crustacean resources

Major groups in the crustacean landings were non-penaeid shrimps (67.50%) followed by penaeid shrimps (24.35%), crabs (6.47%), stomatopods (1.25%) and lobsters (0.43%). Major gears contributing to crustacean landings were dolnets (59.76%) followed by multiday trawlnets (25.59%), mechanised trawlnets (11.42%), gillnets (2.92%) and other gears (0.31%). Among penaeid shrimps, *Parapenaeopsis* sp. (42.40%) dominated the catch followed by *Solenocera* sp. (32.07%), *Metapenaeus* sp. (15.58%), *Penaeus* sp. (5.77%), *Metapenaeopsis* sp. (2.94%) and deep-sea shrimp *Aristaeomorpha* sp. (1.24%). *Parapenaeopsis* genus was mainly represented by *P. stylifera, P. sculptilis* and *P. hardwicki* and *Solenocera* genus was mainly dominated by *S. crassicornis*. Similarly, *Metapenaeus affinis*, *M. monoceros* and *M. kutchensis* represented the exploited shrimps under *Metapenaeus* genus. *Fenneropenaeus penicillatus, Penaeus semisulcatus* and *Fenneropenaeus indicus* also contributed to the penaeid shrimp landings of the state. Penaeid shrimp resources were mainly exploited by multiday trawlers (65.5%) followed by dolnetters (22%), gillnetters (8%), single-day trawlers (4%) and other gears (0.50%). Major group in the crab landing was *Charybdis* spp. (56%). *Charybdis feriata* contributed about 17% followed by *Portunus pelagicus* (10%) and *Portunus sanguinolentus* (9%). Crabs were mainly exploited by multiday trawlers (72%) followed by gillnetters (10%), dolnetters (10%) and single-day trawlers (5%). Major groups in the lobster landing were *Panulirus polyphagus* (48%) followed by *Panulirus homarus* (16%) and *Thenus unimaculatus* (15.5%). Lobsters were mainly exploited by gillnetters (51%) followed by multiday trawlnetters (40%), dolnetters (5%), (22.04%) and single-day trawlers (4%). Stomatopods landing was solely contributed by *Oratosquilla* spp. Stromatopods were mainly exploited by dolnetters (39%) followed by single-day trawlers (33%) and multi-day trawlers (28%).

Biology of important crustacean species landed in Gujarat during 2014

Species	Sex	Length range (mm)	Mean length (mm)	Mode length (mm)	Lr (mm)	Lc50% (mm)	Lm50% (mm)	Sex ratio (M:F)
Solenocera crassicornis	Male	47-127	89.51	85.00	47.00	79.11	86.47	1.21
	Female	43-139	91.44	85.00	43.00	80.29	88.33	
Parapenaeopsis stylifera	Male	41-128	93.57	95.00	41.00	89.91	84.50	1.27
	Female	45-144	107.21	95.00	45.00	75.26	93.61	
Metapenaeus affinis	Male	86-171	128.55	135.00	86.00	121.53	116.34	1.12
	Female	80-196	144.21	145.00	80.00	123.07	124.93	
Metapenaeus monoceros	Male	83-194	141.56	145.00	83.00	124.33	123.85	1.25
	Female	89-229	154.17	145.00	89.00	122.52	141.22	
Penaeus semisulcatus	Male	85-209	158.08	165.00	85.00	151.27	134.48	1.18
	Female	87-236	160.32	165.00	87.00	138.44	145.39	

Biological reference points (BRP) for the important crustacean resources landed in Gujarat

Major crustacean sp.	Ecur	Y_{cur} (t)	Y_{cur} (million ₹)	F_{msy} (%)	F_{mey} (%)	$B_{0.5}$ (%)	$SSB_{0.20}$ (%)
Solenocera crassicornis	0.65	12616	2520	240	200	70	140
Parapenaeopsis stylifera	0.62	10314	2009	220	160	70	120
Metapenaeus affinis	0.64	2575	860	340	200	80	170
Metapenaeus monoceros	0.63	1549	541	240	200	60	120
Penaeus semisulcatus	0.67	321	189	220	180	60	140

Non-penaeid catch from dolnets at Nawabunder

Molluscan resources

Cephalopods: Cephalopods were landed mainly by trawlers contributing 98.77% of the total cephalopod landings, followed by mechanised dolnets (0.56%), outboard gillnets (0.28%) and mechanised gillnets (0.16%). Commercially important groups in the cephalopod landings were squids (48%), cuttlefishes (51%) and octopus (1%). Squid fishery (27,591 t) was dominated by *Uroteuthis duvauceli* (65%) followed by *Uroteuthis (Photololigo) singhalensis* (21%), *Loliolus (Loliolus) hardwickei* (2%), *Uroteuthis chinensis* (8%) and *Uroteuthis edulis* (4%). Cuttlefish fishery (29,210 t) comprised *Sepia pharaonis* (43%), *Sepia elliptica* (24%), *Sepia omani* (8%), *Sepia trygonina* (6%), *Sepia aculeata* (4%), *Sepia prashadi* and *Sepiella inermis* (15%). Octopus landings (239 t) were dominated by C*ystopus indicus* (44%), *Amphioctopus membranaceus* (42%) and other octopus (14%).

Biology of important cephalopod resources

Species	Mantle length range (mm)		Mantle mean length (mm)	Sex ratio M:F	Fecundity range	Ova diameter range (µm)
	Female	Male				
U. duvauceli	182-58	205-56	114	1: 1.40	20850 - 30100	0.627 -0.934
U. singhalensis	118-73	234-82	116	1: 0.94	18500 -30200	0.528 - 0.926
Sepia pharaonis	292-145	380-190	261	1: 1.60	1120 - 2980	3.25 - 4.522
Sepia elliptica	130-70	135-72	103	1: 1.38	1850 -3080	1.12 - 2.428
Sepiella inermis	77-44	64-12	55	1: 20	1200 - 2060	0.714 - 1.036

Feeding biology of major cephalopod resources

Species	Fishes	Crabs	Acetes	Shrimps	Molluscs
Uroteuthis duvauceli	53.14	1.73	9.01	34.68	1.43
Uroteuthis singhalensis	82.32	0.95	0.37	11.84	4.52
Sepia pharaonis	66.46	1.67	33.18	1.44	0.24
Sepia elliptica	52.33	6.46	18.27	19.89	3.06
Sepiella inermis	27.19	3.19	54.11	14.4	1.12

Maharashtra

Research Project: FISHCMFRISIL201201000010

Marine fish landings of Maharashtra during 2014 were estimated at 3.44 lakh t with 5.4% decrease from previous year. Pelagic resources contributed 42%, followed by demersal resources (25.8%), crustaceans (27.6%) and molluscs (4.0%). Major fishing gears that supported the fishery were trawlnet (40%), bagnet (34%), purseseine (15.7%), and gillnet (9.4%). Prominent species/groups that contributed to the fishery of the state were non-penaeid shrimps (15.1%), penaeid shrimps (10.2%), Bombayduck (9.6%), oilsardine (8.7%), croakers (8.5%), golden anchovy (4.1%), ribbonfishes (4.0%), threadfin breams (3.6%), catfishes (3.2%) and Indian mackerel (2.8%). The decline in catch from the previous year may be attributed to the increased operational cost (especially fuel) and poor returns that compelled fishermen not to venture into sea. Oilsardine and mackerel emerged as the major species relegating traditional Bombayduck, due to purseseining which gained prominence during 2012 and 2013. Catch rates in purseseines remained at the highest (307.5 kg h^{-1}) followed by bagnet (31.6 kg h^{-1}), trawl (23.2 kg h^{-1}) and gillnet (13.0 kg h^{-1}).

Value of total fish landings in the state at first point of sale has been estimated as ₹2,694 crores. Major share of revenue was contributed by trawlers (38.8%) followed by dolnetters (31%), gillnetters (18%), purseseiners (11.4%), hook and line (0.1%) and non-mechanised gears (0.9%). Though total fish landings in Maharashtra showed 5.4% decline, the revenue increased by 8.6% compared to ₹2,479 crores in 2013.

Pelagic resources

Pelagic finfishes contributed 1.41 lakh t to the total fish landings (41.2%) with 12.7% increase. Clupeids contributed high (29%) followed by Bombayduck, (23.3%), engraulids (11%), carangids (10%), ribbonfishes (9.5%), Indian mackerel (6%), seerfishes (5.1%), tuna (3.5%), barracudas and full beaks & half beaks (1%).

Sardine: *Sardinella longiceps* contributed 8.7% (30039 t) to the total fish landings in Maharashtra, ranking as the 4th largest contributor with 77% increase compared to the previous year. Purseseine was the major gear that caught *S. longiceps* (90%) followed by trawl (4.7%) and non-mechanised gears (3.5%).

Golden anchovy: Golden anchovy *Coilia dussumieri* contributed 4% (14056 t) to the total marine fish landings, with 43% increase over the last year. Bagnets contributed highest (74%) followed by trawl (21%) and gillnet (4.5 %).

Indian mackerel: *Rastrelliger kanagurta* contributed 2.8% (9638 t) to total fish landings, forming the tenth largest resource in Maharashtra. Almost 53.6% of the mackerel landing was by purseseine followed by trawl (15.5%), gillnets (14.3%) and non-mechanised gears (15.7%).

Bombayduck: With estimated catch of 33123 t, Bombayduck formed 9.6% of the total fish catch, registering an increase by 21% from previous year. About 85% of catch was contributed by dolnets and the remaining 15% by trawls. Size ranged from 45 to 374 mm TL.

Ribbonfish: Ribbonfish contributed 3.9% (13420 t) to the total fish catch with a decrease of 26% from the previous year. Trawlnet contributed the major catch (78.3%) followed by dolnet (16.5%) and purseseine (3.7%). *Trichiurus lepturus* was the major species with size range of 390 to1109 mm TL.

Tuna: The estimated catch of tuna was 5468 t, with 24% decrease over the last year. About 65% of tuna were caught by purseseine, 32% by gillnets and 3% by multi-day trawlers. *Euthynnus affinis* was the most dominant species (51.5%), followed by *Thunnus tonggol* (35.1%), *Auxis thazard* (3.3%) and others (10.1%). Contribution of *E. affinis* to the total tuna landings decreased from 64% (2013) to 51.2% (2014), while contribution of *T. tonggol* increased from 32% (2013) to 34.3% (2014).

Seerfishes: Seerfishes contributed 7785 t (2.3%) to the total fish catch. *Scomberomorus commerson* (61%) and *Scomberomorus guttatus* (39%) were the species that contributed to the fishery. About 49% of *S. guttatus* was contributed by gillnets followed by dolnet (19.5%), trawl (17%), purseseine (12%), and hook & line (1.3%).

Barracuda: With 1376 t barracuda contributed 0.4% to the total fish catch showing 17.2% decline over last year. Almost 90% of the barracuda landing was contributed by the single species sawtooth barracuda, *Sphyraena putnamae*, and the other species in the catch were *Sphyraena jello*, *Sphyraena obtusata* and *Sphyraena barracuda.* Purseseine contributed highest (58.7%) followed by gillnet (29.1%), trawl (11.1%) and dolnet (1.1%).

Cobia: Total catch of *Rachycentron canadum* was estimated at 374 t with 36% decline over past year landings (587 t). The size range was 730 to 749 mm TL and sex ratio 1:0.78 (M: F). Maturing specimens were recorded during November. Main food items were crustaceans (90.4%) followed by fish (7.8%), cephalopods (1.3%) and gastropods (0.4%).

Bombayduck landed by dolnetters at Arnala

Biological characteristics of important pelagic fishes

Species	Length range, TL (mm)	Maturity season
Sardinella longiceps	100-209	January-May
		October-November
Rastrelliger kanagurta	120-289	January-May, August
Coilia dussumieri	50-204	January-February
		October-December
Harpodon nehereus	5 -374	March-April
Trichiurus lepturus	390-1109	February-May
		November-December
Euthynnus affinis	215-455	October
Auxis thazard	248-402	February, August, December
Scomberomorus guttatus	170-689	November - December
Sphyraena putnamae	366-809	May and September

Major food items observed in the gut of pelagic fishes.

Species	Major prey items
Sardinella longiceps	Copepods, *Coscinodiscus, Ceratium, Nitzia, Tintinids, Pleurosigma, Naviculla, Prorocentrum* and *Dinophysis*
Coilia dussumieri	*Acetes* sp., copepods and shrimps
Rastrelliger kanagurta	*Coscinodiscus, Dinophysis, copepods, Pyrophacus, Navicula* and *ostracods*
Harpodon nehereus	*Nematopalaemon tenuipes, Acetes* sp., *Coilia dussumieri, Harpadon nehereus* and *Bregamaceros macclellandi*
Trichiurus lepturus	*Acetes* spp., young ones of *T. lepturus* and prawn
Thunnus tonggol	Fish and crustaceans
Auxis thazard	Teloest fishes
Scomberomorus guttatus	*Stolephorus* spp., *Uroteuthis duvauceli* and *Sardinella longiceps*
Sphyraena putnamae	*Uroteuthis duvauceli,* sardine, ribbonfish and *Decapterus russellii*
Coryphaena hippurus	Fish, cephalopods, crustaceans and digested unidentified matter

Fullbeaks: Total catch of fullbeaks was estimated at 420 t of which *Ablennes hians* comprised 250 t (60%) followed by *Strongylura* sp. (36%) and *Tylosurus* sp. (4%). Purseseines landed 80% of fullbeaks, followed by trawl (11%) and gillnet (9%). Compared to previous year, the catch increased by 29.1%. *A. hians* were in the size range between 840 to 859 mm TL. Sex ratio was 1:6.5. Maturing females (50%) were found in March. Main food item observed was semidigested fish (100%).

Dolphinfish: The estimated catch of *Coryphaena hippurus* was 298 t, which showed 48% decline compared to previous year. *C. hippurus* showed size range between 410 to 875 mm TL; Sex ratio was 1:2.5. Gravid specimens (100%) were observed in December.

Wolfherring: The estimated catch of *Chirocentrus* spp. was 2115 t (0.6% to total fish catch) which showed 60% increase over the previous year. Size range for *C. nudus* was 381 to 400 mm TL; sex ratio 1:3.8 (M: F); about 60% of the specimens were in immature condition; food mainly consisted of fish (82.5%) followed by cephalopods (11.5%) and shrimp (6%).

Landing of *E. affinis* at Sassoon Dock

Population parameters of major pelagic fish species

Species	L∞ (TL, mm)	K yr^{-1}	Z	M	F	E	E_{max}	Status of exploitation
Harpadon nehereus	399	0.90	3.4	1.5	1.9	0.56	0.55	Over-exploited
Coilia dussumieri	207	1.2	3.2	2.2	1.0	0.32	0.60	Under-exploited
Rastrelliger kanagurta	299	0.70	2.4	2.2	0.2	0.10	0.70	Under-exploited
Sardinella longiceps	211	1.00	2.7	2.0	0.7	0.26	0.60	Under-exploited
Scomberomorus guttatus	696	0.75	2.0	1.1	0.9	0.43	0.65	Under-exploited
Trichiurus lepturus	1230	0.63	3.0	0.8	2.1	0.71	0.60	Over-exploited

Demersal resources

Estimated total catch of demersal resources during 2014 was 88804 t which formed 25.8% of the total fish landings of the state. Nearly 67% of the demersal resources were landed by trawlers followed by gillnet (14.3%) and bagnet (11.7%). When compared to 2013 the catch recorded 0.1% increase. Catch was mainly contributed by croakers (33%), threadfin breams (14%), catfishes (12.4%), promfrets (11.7), flatfishes (7.7%), elasmobranchs (6.5%), rockcods (9.1%), lizardfishes (2%), whitefish (1.6%) and eels (1.3%).

Croakers: Sciaenids contributed 29399 t to total fish catch of Maharashtra. Catch landed by trawlers, gillnetters, dolnetters and purseseiners were 24200 t, 1796 t, 2678 t and 635 t respectively. The catch rate (kg h^{-1}) for trawlers, gillnetters, dolnetters and purseseiners was 4.0, 0.73, 0.72 and 3.62 respectively. Trawl and dolnet catch of sciaenids increased by 11.4% and 61.5% respectively as compared to previous year, whereas in gillnets it decreased by 26.5%. Relative abundance showed dominance of J*ohnius borneensis (=J. vogleri)* (27.8%) followed by *Johnius macrorhynus* (25.5%), *Otolithes cuvieri* (23.5%) and *Otolithes biauritus* (11.8%). Appearance of *Pennahia anea* (0.5%) and *Johnius belangeri* (0.6%) in the trawl catch was significant during the period.

Threadfin breams: Nemipterids were exploited exclusively by trawlers that amounted to 12365 t with annual catch rate of 2.1 kg h^{-1} (3.6% in total fish landings). In comparison to previous year, Nemipterid catch decreased by 23.4%. The major species were *N. japonicus* (58%), *N. randalli* (=*mesoprion*) (26.5%) and *N. bipunctatus* (14.6%).

Catfishes: Catfish catch along the Maharashtra coast exploited by trawlers, gillnetters, dolnetters and purseseiners was 2350 t (1.7%), 3698 t (11%), 1212 t (1.0%) and 3724 t (7.0%) respectively. It formed nearly 3.2% of the total fish catch. Annual catch rate (catch h^{-1}) for trawl, gillnet, dolnet, and purseseine was 0.4, 1.5, 0.3 and 21.2 kg respectively. As compared to previous year, catfish landings declined in trawlnet and purseseine by 20% and 67% respectively; while increased in dolnet and gillnet by 58% and 8% respectively. Overall catfish catch decreased by 40%. Major catfish species landed were *Osteogeneiosus militaris* (33.2%), *Plicofolis (=Arius) dussumeiri* (25%), *Nemapteryx caelata (= Arius caelatus)* (21%) and *Plicofolis (=Arius) tenuispinis* (15%).

Pomfrets: Pomfret landings in trawl, gillnet, dolnet and purseseine in Maharashtra were 954, 3955, 4952 and 538 t respectively. Nearly, 47.5% of the catch was exploited by dolnet and 38% by gillnets. In the total fish catch, pomfrets contributed 0.7% in trawl, 12.3% in gillnet, 4.2% in dolnets and 1.0% in purseseine. *Pampus argenteus* was the most dominant species in gillnet (76%) and dolnet (91%) while *Parastromateus niger* was the dominant species in trawl and gillnet (17%) and purseseine (100%). The size range of silver pomfret in dolnet was 90 to 280 mm FL (mean size 160 mm FL), in gillnets 100 to 290 mm FL (mean size 174 mm FL) and in trawl 60 to 300 mm FL (mean size 174 mm FL). Trawlers (69%) and gillnets (77%) landed mostly undersized pomfrets, but by virtue of total catch, dolnets (86%) damaged far greater number of silver pomfrets.

Solefish: Soles were mainly landed by trawlers (6344 t), gillnetters (86 t) and dolnetters (400 t) forming about 4.6, 0.09 and 0.32% of the total catch at the catch rate of 1.07, 0.03 and 0.08 kg h^{-1}, respectively. The catch increased by 106% and effort decreased by 7.6% whereas catch rate and percentage contribution increased by 123% and 11.7% in comparison to last year.

Cynoglossus arel landed at Mumbai

Elasmobranchs: Elasmobranch landings (5779 t) by trawlers, gillnetters, dolnetters, and purseseiners were 2462, 2630, 645, 38 and 4 t respectively. Nearly 45% of elasmobranch catch was exploited by the gillnetters followed by trawlers (42%). Compared to the previous year, the catch increased by about 10% in gillnetters and 6.8% in trawlers. Sharks were the dominant group (75%) followed by rays (21%) and skates (4.5%) in trawlers, where as in gillnetters sharks were the major group (92%) followed by rays (6.6%) and skates (1.5%). *Scoliodon laticaudus* was dominant in trawl (88%), gillnet (65.5%) and dolnet (96%). In trawlers, *Himantura uarnacoides* (40%) and *Rhynchobatus* sp. (99%) were the most dominant among rays and skates respectively.

Scoliodon laticaudus landed at Sassoon Dock, Mumbai

Groupers: Groupers were mainly landed by the trawlers (5529 t) forming about 4.0% of the total catch at the catch rate of 0.93 kg h^{-1}. The relative species abundance showed dominance of *Epinephelus diacanthus* (83.7%) followed by *E. tauvina* (9.6%) and *E. latifasciatus* (5.4%). *Epinephelus areolatus* was the least in 2014 (0.16%). Almost 98.8% of *E. diacanthus* catch was dominated by juveniles.

Lizardfish: Lizardfishes contributed 1801 t, exclusively landed by bottom trawlers which formed 0.5% of the total fish catch with a catch rate of 0.3 kg h^{-1}. Compared to the previous year, catch increased by about 65%. *Saurida tumbil* (94%) was the dominant species followed by *S. undosquamis* (6 %).

Whitefish/False travelly: *Lactarius lactarius* (1401 t) catch along the Maharashtra coast exploited by trawlers, gillnetters, dolnetters and non-mechanised gears were 1252, 140, 2 and 7 t respectively. It formed nearly 0.41% of the total fish catch. The contribution of this resource by trawlnet was high (81%).

Polynemids: Polynemids contributed 1060 t to the total fish catch of Maharashtra, registering 20% decrease when compared to last year. Catch in trawl, gillnet and dolnet was 506 t, 416 t, and 114 t respectively. Contribution of this resource in the above gears was 0.4%, 1.3% and 0.1% respectively. Catch was mainly contributed by *Polydactylus (=heptadactylus) mullani* (68%) in trawl, *Polynemus indicus* (87%) in gillnet and *Eleutheronema tetradactylum* (95%) in dolnet.

Biological parameters of demersal resources

Species	Length range (mm)	Mean size (mm)	Sex ratio (M:F)	Immature (%)	Mature (%)	Gravid/ Spent (%)
Scoliodon laticaudus	180-500 (M)	375 (M)	1:1.1	32 (M)	68 (M)	7 (M)
	180-540 (F)	366(F)		44 (F)		4 (F)
Rhizoprionodon oligolinx	340-780 (M)	600 (M)	1:1.5	40 (M)	60 (M)	0 (M)
	360-740 (F)	640(F)		22 (F)	52 (F)	6 (F)
Rhizoprionodon acutus	580-920 (M)	726 (M)	1:0.9	18 (M)	82 (M)	0 (M)
	560-900 (F)	637 (F)		67 (F)	13 (F)	20 (F)
Carcharhinus macloti	320-920 (M)	749 (M)	1:1.1	55 (M)	45 (M)	0 (M)
	400-920 (F)	747 (F)		61 (F)	24 (F)	16 (F)
Himuntura imbricata	130-290 (M)	216 (M)	1: 1.12	26 (M)	74 (M)	0 (M)
	150-290 (F)	231(F)		34 (F)	48 (F)	9 (F)
Parastromateus niger	130-390	232	1:0.79	79	20	1
Pampus argenteus	120-239	160	1:2.07	44.6	44.7	10.8
Polydactylus(=heptadactylus) mullani	90-260	144	1:0.28	25.7	71.6	2.7
Saurida tumbil	110-420	228	1:0.67	68.2	21.9	9.9
Plicofollis (=Arius) tenuispinis	190-510	316	1:0.49	95	2	3
Osteogeneiosus militaris	170-430	306	1:0.39	90	6	4
Nemipterus japonicus	40-300	170	1:0.58	24	75	1
Nemipterus randalli (=mesoprion)	50-290	120	1:0.23	42	58	0
Lactarius lactarius	50-340	152	1:0.71	46	52	2
Johnius macrorhynus	90-270	198	1:0.44	19.6	35.5	44.9
Johnius borneensis (= Johnieops vogleri)	80-300	196	1:0.61	17.6	60.3	22.1
Johnius dussumieri (= Johnieops sina)	70-220	162	1:1.07	45.8	38.3	15.8
Otolithes cuvieri	80-300	195	1:0.86	51.9	21.3	26.8
Otolithoides biauritus	119-1099	458	1:1.14	94.6	5.4	0
Protonibea diacanthus	169-1209	373	1:1.86	100	0	0
Epinephelus diacanthus	130-410	220	1:2.10:0.11	85.2	10.8	4.1
Cynoglossus arel	160-310	251	1:0.96	28.3	56.4	15.2
Upeneus moluccensis	100-350	200	1:0.98	50.5	28.4	21.1

Population parameters of demersal species landed in Maharashtra

Species	L_∞ (mm)	K yr^{-1}	Z	M	F	E	E_{max}	Status of stock
Scoliodon laticaudus (M)	649	0.79	3.8	1.2	2.7	0.68	0.85	Under-exploited
Scoliodon laticaudus (F)	682	0.74	2.8	1.2	1.7	0.59	0.69	Under-exploited
Himuntura imbricata (M)	362	0.59	4.4	1.2	3.1	0.73	1.00	Under-exploited
Himuntura imbricata (F)	372	0.59	2.8	1.1	1.6	0.59	0.95	Under-exploited
Parastromateus niger	488	0.60	3.9	1.1	2.8	0.72	0.87	Under-exploited
Pampus argenteus	344	0.76	3.8	1.3	2.4	0.64	0.73	Under-exploited
Polydactylus (=heptadactylus) mullani	303	0.58	3.3	1.2	2.1	0.63	0.63	Optimally exploited
Saurida tumbil	505	0.70	3.0	1.2	1.7	0.59	0.62	Under- exploited

Plicofollis (=Arius) dussumieri	594	0.70	2.0	1.1	0.9	0.44	0.56	Under-exploited
Nemapteryx caelata (= Arius caelatus)	701	0.65	2.5	1.0	1.4	0.58	0.49	Over-exploited
Plicofollis (=Arius) tenuispinis	645	0.40	1.8	0.8	1.0	0.57	0.57	Optimally exploited
Osteogeneiosus militaris	581	0.89	5.6	1.3	4.2	0.76	0.65	Over-exploited
Nemipterus japonicus	352	0.66	3.2	1.3	1.9	0.60	0.62	Under exploited
Nemipterus randalli (=mesoprion)	335	0.79	0.59	1.4	4.4	0.75	0.58	Over-exploited
Lactarius lactarius	362	0.49	2.3	1.0	1.3	0.55	0.54	Over- exploited
Johnius macrorhynus	305	0.86	7.8	1.6	6.1	0.79	0.89	Under exploited
Johnius borneensis (=Johnieops vogleri)	325	0.89	7.4	1.5	5.8	0.79	0.45	Over-exploited
Johnius dussumieri (=Johnieops sina)	298	0.56	4.3	1.2	3.0	0.72	0.86	Under-exploited
Otolithes cuvieri	414	0.52	2.5	1.0	1.5	0.59	0.63	Under exploited
Otolithoides biauritus	1820	0.51	3.7	0.7	3.0	0.81	0.42	Over-exploited
Protonibea diacanthus	1420	0.52	1.6	0.7	0.9	0.55	0.43	Over-exploited
Epinephelus diacanthus	585	0.86	3.1	1.3	1.8	0.57	0.48	Over-exploited
Cynoglossus arel	379	0.90	4.1	1.5	2.5	0.62	0.73	Under -exploited
Upeneus moluccensis	235	0.79	2.5	1.6	0.8	0.35	1.00	Under-exploited

Crustacean resources

The total crustacean landings (95075 t) showed 22.5% decrease over 2013. Among them major contributors were non-penaeid shrimps (54.6%), penaeid shrimps (37.1%), stomatopods (6.0%), crabs (1.6%) and lobsters (0.4%). Crustaceans were mainly landed by dolnetters (59.4%) and trawlers (40.2%).

Shrimps: Shrimps formed 91.8% of the crustacean landings. Among the shrimps, non-penaeids contributed 54.6% and penaeids 37.1%. Catch rate of shrimps declined by 12.2% compared to last year. Among penaeid shrimps, *Parapenaeopsis stylifera* dominated trawl catch (30.5%) followed by *Metapenaeus affinis* (30.2%), *Solenocera crassicornis* (14.5%) and *Metapenaeus monoceros* (14.2%). Among the non-penaeid shrimps *Nematopalaemon tenuipes* dominated the fishery with 93% followed by *Acetes* sp. (6%) and *Exhippolysmata ensirostris* (1%). *Fenneropenaeus merguiensis* ranged between 93 to 183 mm TL with mean size at 138 mm for male and 88 to 233 mm TL with mean size at 151 mm for female. *S. crassicornis* ranged from 53 to 103 mm TL with mean size at 67 mm for male and 58 to 133 mm with mean size at 88 mm for female. *M. monoceros* ranged from 93 to173 mm with mean size at 133 mm for male and 93 to 213 mm TL with mean size at 152 mm for female. *M. affinis* ranged between 68 to 148 mm TL with mean size at 119 mm for male and 58 to178 mm TL with mean size at 127 mm for female. Sex ratio was 1:1.5. *P. stylifera* ranged between 63 to 103 mm TL with mean size at 83 mm for male and 55 to158 mm with mean size at 107 mm for female. A record size *P. stylifera* measuring 158 mm TL was observed in April at New Ferry Wharf fish landing centre in Mumbai.

Record size *Parapenaeopsis stylifera* (158 mm TL) landed at New Ferry Wharf, Mumbai

Lobsters: Lobsters with estimated catch of 420 t formed 0.4% of the crustacean landing; 76.1% by trawlers and 23.1% by gillnetters. *Panulirus polyphagus* was the only species in the catch forming 100%.The size of *P. polyphagus* ranged from 95 to 395 mm TL with mean size at 174 mm for male and 105 to 345 mm TL with mean size at 196 mm for female. Lobsters in the size range of 115 to 205 mm TL formed the mainstay of the trawl catch with annual mean size at 135 and 255 mm TL for the males and females. Berried females were observed round the year with maximum in November (67.5%).

Crabs: Crabs with 1565 t catch formed 1.6% of the crustacean landings. They were mostly landed by trawlers (68%) and the rest 32% by other gears. *Charybdis feriatus* (70.1%) accounted for the bulk followed by *Portunus sanguinolentus* (19.2%), others (7.1%) and *Portunus pelagicus* (3.4%). *C. feriatus* ranged in carapace width (CW) from 68 to 158 mm with mean size at 95 mm for male and 63 to 143 mm with mean size at 88 mm for female. The size range of *P. sanguinolentus* in the fishery was 78 to 178 mm CW with mean size at 114 mm for male and 78 to173 mm with mean size at 118 mm for female.

The population parameters of crustacean resources in Maharashtra

Species	Sex	L_∞ (TL/*CW, mm)	K yr^{-1}	Z	M	F	E	E_{max}	Status of stock
M. affinis	F	185	1.8	4.9	3.0	1.9	0.39	0.62	Under-exploited
	M	152	1.5	3.3	2.8	0.5	0.16	0.64	Under-exploited
M. monoceros	F	216	1.1	2.8	2.1	0.7	0.27	0.61	Under-exploited
	M	176	1.4	3.2	3.2	0.6	0.19	0.65	Under-exploited
F. merguiensis	F	236	1.3	3.2	2.2	0.9	0.29	0.59	Under-exploited
	M	199	1.4	6.6	2.5	4.3	0.63	0.65	Under-exploited
P. stylifera	F	161	1.2	3.7	2.4	1.3	0.35	0.62	Under-exploited
	M	110	1.1	4.2	2.6	1.6	0.39	0.70	Under-exploited
S. crassicornis	F	150	1.2	6.7	2.5	4.2	0.63	0.62	Over-exploited
	M	108	1.5	10.3	2.3	7.1	0.69	0.69	Optimally-exploited
**C. feriatus*	F	149	1.6	6.9	3.0	3.8	0.56	0.68	Under-exploited
	M	170	1.2	3.7	2.3	1.4	0.37	0.58	Under-exploited
**P. sanguinolentus*	F	181	1.3	5.6	2.4	3.2	0.60	0.61	Under-exploited
	M	190	1.3	2.8	2.4	0.4	0.16	0.65	Under-exploited
P. polyphagus	F	375	1.6	3.6	2.2	1.3	0.37	0.49	Under-exploited
	M	438	1.9	8.2	2.4	5.7	0.70	0.49	Over-exploited

Molluscan resources

Total annual catch of cephalopods by trawlers was 12429 t with a catch rate of 2.10 kg h^{-1} forming 9% of the total landings. Indian squid, *Uroteuthis duvauceli* dominated with landings of 7114 t followed by cuttlefishes *Sepiella inermis* (2004 t), *Sepia elliptica* (1638 t), *Sepia pharaonis* (1221 t) and the octopus species, *Cistopus indicus* (452 t). Annual cephalopod catch by trawlers decreased by 39.5% and the catch rate by 34.5% from previous year.

U. duvauceli showed size range between 50 to 299 mm DML. They mainly fed on fish (52.1%), shrimps (44.6%) and squid (2.9%). The sex-ratio was 1:0.89. Maximum number of mature and gravid specimens of *U. duvauceli* was observed in January. Fecundity ranged between 130 to 1,240 and the ova diameter between 0.5 to 1 mm.

S. pharaonis mainly fed on fish (37.7%) followed by shrimps (45.8%) and crab (16.6%). The sex-ratio was 1:0.47. Mature females were observed during February. Fecundity ranged between 206 to 708 and the ova diameter was 2 to 5 mm.

Cistopus indicus: Fish formed the main gut content (72.3%) followed by shrimps (21.4%) and digested matter (6.3%). Sex-ratio was 1:0.33. Mature females were observed during February. The fecundity ranged between 380 to 9040 and the ova diameter 1 to 5 mm.

Population parameters of molluscan species landed in Maharashtra

Species	L_∞ (DML, mm)	K yr^{-1}	Z	M	F	E	E_{max}	Status of stock
Uroteuthis duvauceli	359	0.89	3.2	1.8	1.1	0.40	0.40	Optimally exploited
Sepia elliptica	214	0.97	3.3	1.9	1.9	0.45	0.47	Under-exploited
Sepia pharaonis	401	1.21	3.5	1.9	3.1	0.65	0.55	Over-exploited
Sepia inermis	108	0.91	4.0	2.5	2.9	0.52	0.59	Under exploited
Cistopus indicus	242	0.78	3.1	1.4	1.8	0.53	0.47	Over-exploited

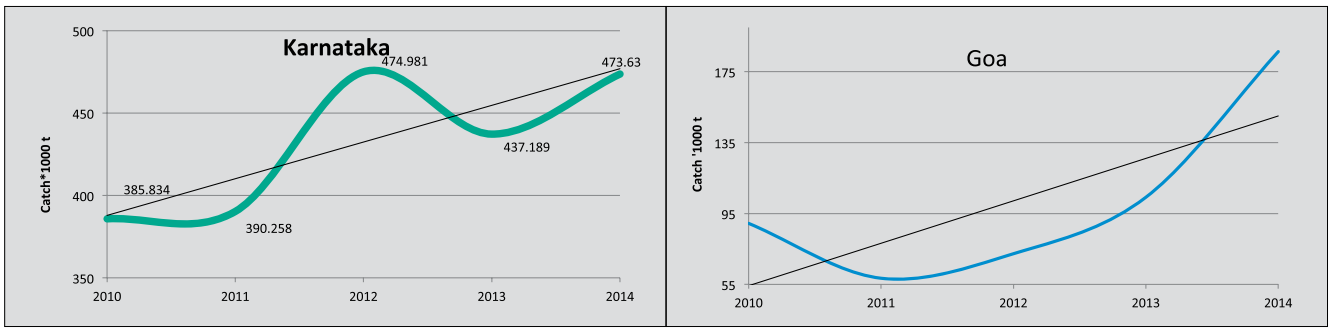
Landing of *U. duvauceli* in Mumbai

Karnataka and Goa

Research Project: FISHCMFRISIL201200600006

Total estimated marine fish landing in Karnataka and Goa was estimated at 473630 and 186350 t respectively in 2014. Total catch in Karnataka was 20% above five year average (2009-2013) for Karnataka and 135% above the five year average catch of Goa during the same period. The production per km of coast was estimated as 1579 and1679 t respectively for Karnataka and Goa. Total fishery during 2014 was valued at an estimated ₹2734.41 crores and ₹650.03 crores in Karnataka and Goa respectively. Improved catches of oilsardine, increased operations of large meshed purseseines resulting in better exploitation of large pelagics and delayed onset of rains along Karnataka-Goa coast resulted in increased overall catches in both states especially during the post-monsoon months.

Extent of fishing area by different gears was mapped. The non-mechanised sector operated close to the shore within 12 nautical miles (nm) and at depths ranging from 2 to 8 m. The mechanised multi-night trawlers operated mostly beyond 12 nm at depths ranging from 10 to beyond 200 m and operation



Trend in total marine fish landings in Karnataka and Goa (2010 -2014)

extent spread over four states - Kerala in the south to Maharashtra in the north. The extent of purseseine operation was off Karnataka coast at depths ranging from 13.5 to 98 m and that of gillnets at depths ranging from 20 to beyond 100 m.

Operational area and depth range of different gears employed in Karnataka

Gears	Latitude (degree-minute)	Longitude (degree-minute)	Depth range (m)
Singleday trawl (SDF)	13.09 - 13.92	74.30 -74.68	7.5 - 25.5
Multiday trawl (MDF)	11.18 - 15.40	72.01 - 74.50	10 - >200
Gillnet	12.46 - 12.85	74.51 - 74.72	22 - >100
Purseseine	12.00-12.59	74.252-74.540	13.5 - 98
Ringseine	13.23 - 14.31	74.23 - 75.00	4- 28
Indigenous gears	Close to shoreline		2-6

As observed in the past, mechanised sector contributed maximum to the total catch in both states, which comprised 83.2% in Karnataka and 92.5% in Goa followed by the motorised sector and the non-mechanised sectors. Trawls were the dominant gear in Karnataka whereas purseseines were dominant in Goa.

Oilsardine formed the most dominant fishery in Karnataka and Goa. Pelagic resources dominated the catch in both states forming 65.1% in Karnataka and a whopping 91% in Goa. Demersal resources formed 21.6% in Karnataka followed by crustacean resources (6.2%) and the molluscs (5.6%). In Goa, demersal resources formed 3.9% and crustaceans 4.5%. The dominance of purseseines and the minimal operation of multiday trawlers at Goa is the reason for such poor representation of resources other than the pelagics.

Rapid stock assessment of major fishery resources

Rapid stock assessment (RSA) for 30 commercially important fish groups were done for a period of 25 years. Of these, 13 groups (catfish, oilsardine, lizardfish, half & fullbeaks, perches, croakers, ribbonfish, carangids, whitefish (bigjawed jumper), pomfrets, crabs, cepahalopods and squids) were abundant; 12 groups (skates, rays, Indian mackerel, lesser sardines, seerfish, barracuda, silverbellies, flatfish, penaeid shrimps, stomatopods, cuttlefish and octopus) were less abundant and 5 groups (sharks, whitebaits, tunas, billfish and crustaceans) were in declining state.

In Goa the catch by purseseines dominated the landings and landed mostly pelagic resources. RSA was done only for this gear taking into account the dominant pelagic groups. Of the 9 important fish groups during 2000 to 2014, three groups (oilsardine, other sardines and tunas) were less abundant and 6 groups (catfishes, *Stolephorus* spp., ribbonfish, carangids, black pomfret and seerfish) were in declining state.

Pelagic resources- Karnataka

Contribution of pelagic resources to the total marine fish catch in Karnataka registered a gradual increase over the years. Pelagic fishes with an estimated catch of 308345 t formed 65% of the total catch of Karnataka. Trawls operating fish net contributed 43% of the pelagic catch followed by purseseines (33%), ringseines (17%) and gillnets (5%). Non-mechanised sector operating varied gears mostly landed pelagic fishes but contributed only 1.4%.

Sardines: Sardine landings comprised oilsardine (94%) and lesser sardines (6%). Catch of oilsardine over the years (2010-2015) registered an increasing

Large shoal of oilsardine being harvested by purseseine and ringseine

trend and contributed 20% in 2010 to 30% in 2014, to total fish catch. Purseseines, trawls, ringseines and other indigenous gears contributed 55, 16, 26, and 3% respectively.

Ribbonfish: Ribbonfishes with an estimated catch of 17911 t formed 3.8% of total and 5.8% of pelagic landings in the state The contribution of ribbonfish to the total catch fluctuated over the five year period (3.8 to 6.4%) but is in the abundant state. Trawls, mainly the multi-day fishing trawls (MDF) was the major gear that landed 97.7% of the total ribbonfish catch. Other gears that contributed to the catch were single-day fishing trawls (SDF) (1.3%), purseseines (0.3%) and gillnets (0.7%).

Mackerel: Mackerel landings (68362 t) contributed 14.4% of total catch in 2014 and fluctuated between 7.1 in 2012 to 19.9% in 2011. Trawls, purseseines, ringseines, gillnets and indigenous gears contributed 49.9, 31.6, 8.5, 8.1 and 1.7% respectively to the total mackerel catch during 2014. Stock status indicated less abundant state.

Carangids: Carangids formed 2 to10% of the total fish catch of Karnataka. Scads (*Decapterus* spp.) were most dominant (27549 t) which formed 66% of total carangid catch during 2014.

Whitebaits: Anchovies comprising mainly whitebaits (*Stolephorus* spp.) is an important group contributing to the catch of the state and plays a crucial role as prey for several other fishes higher up in the food chain. During the five year period, catch fluctuated between 4372 t in 2012 and 6886 t in 2010 forming 0.9 to 1.8% of the total catch.

Tunas: Tunas with a catch of 1550 t formed 0.3% of the total fish catch during 2014. The resource was represented by five species with a dominance of kawakawa *Euthynnus affinis*, forming 67.9% of tuna catch. The catch has been fluctuating over the five year period and the stock status indicated a declining trend for tunas in general as well as for *E. affinis*. Gillnets (8.1%), purseseines (85.6%) and trawls (3.7%) were the major gears exploiting tunas.

Seerfish: Seerfishes were exploited mainly by the gillnets (18.2%), trawls (68.4) and purseseines (11.8%). Seerfish stock has indicated less abundant status.

Pelagic resources - Goa

Contribution of pelagic resources to the total marine fish catch in Goa registered a gradual increase over the years. Pelagic fishes with an estimated catch of 169585 t comprised 91% of the total catch of Goa during 2014. Major groups that constituted the pelagic resources included oilsardines, mackerel, carangids and lesser sardines. Mechanised sector was dominated by purseseiners which contributed 94% of the total pelagic fish catch. Trawls and gillnets contributed 5% and 1% respectively to pelagic fish landings.

Sardines: Sardine catches comprised oilsardine (98.9%) and lesser sardines (1.1%). The catch of oilsardine over the years (2009-2014) registered an increasing trend and contributed 13.33% in 2010 to 78.9% in 2014 to total fish catch of Goa.

Mackerel: Mackerel landings (9150 t) contributed 4.91% of total catch in 2014. Over the last five years, highest contribution of 38.62% was in 2010.

Other resources viz., whitebaits, ribbonfish, scads, horse mackerel, kawakawa (*Euthynnus affinis*), oriental bonito (*Thunnus tonggol*), narrow-barred Spanish mackerel (*Scomberomorus commerson*), billfish and barracuda contributed 0.07, 0.12, 0.15, 0.60, 2.81, 0.29, 0.24, 0.06 and 0.06% respectively to the total fish catch of Goa.

Biological characteristics of important pelagic species

Species	Length range (mm)	Mean length (mm)	Sex ratio (M:F)	Immature (%)	Mature (%)	Gravid/Spent (%)
S. longiceps (purseseine)	120-215	161	1:1.5	83.82	16.18	9.1/90.9
S. longiceps (trawl)	110-215	166	1:1	41.35	58.65	4.83/95.2
S. fimbriata	140-190	169	1:0.8	0	100	0/100
S. gibbosa	145-185	165	1:0.6	0	100	0/100
S. albella	140-175	159	1:1.5	0	100	0/100
R. kanagurta (purseseine)	90-275	245	1:0.79	0	100	0/24.7
R. kanagurta (trawl)	95-260	208	1:1.04	4.9	95.1	15.7/84.3
T. lepturus	120-500	260	1:1.4	30.4	69.6	7.3/61.6
E. devisi	60-108	84	1:0.7	0.7	99.3	1.8/97.9
S. waitei	36-112	74	1:0.7	19.5	80.5	0.1/66.6
R. canadum	300-1360	546	1:1.42	20	80	0/13
S. commerson	340-1280	418	1:2.8	50	50	0/59
E. affinis	180-680	413	1:1.4	33.3	66.7	0/23.6
A. thazard	300-400	360	1:1.2	27.7	72.3	0/25
S. obtusata	120-460	230	1:1.11	23.1	76.9	20.5/60
S. putnamae	220-880	360	1:1.13	78.5	21.5	0/43
S. jello	20-1000	350	1:1.41	16.3	83.7	16.7/57
S. barracuda	60-1520	1260	1:3	0	100	0/83
S. commersonianus	220-1040	487	1:0.54	60	40	0/50
S. tol	200-680	332	1:1.18	23.1	76.9	15/50
S. tala	200-540	350	1:0.6	19.2	80.8	14.3/57
S. nigrofaciata	140-520	200	1:1.9	57.90	42.10	9.1/9.1
C. hippurus	360-1280	490	1:2.5	6.7	93.3	21.4/57.1
A. hains	580-1140	880	1:1.33	25	75	33/33
S. crocodilus	620-1240	970	1:1.60	12.5	87.5	42.9/57
M. cordyla	109-409	266	1:1.35	39.6	60.4	10.3/38
D. russelli	100-190	189	1:1.27	32.6	67.4	12.3/55

Major food items observed in the gut of pelagic fishes

Species	Major food items
R. kanagurta	*Trichodesmium, Coscinodiscus, Fragilaria, Pleurosigma, Biddulphia, Nitzchia, Skeletonema, Navicula, Triceratium, Ceratium, Peridinium, Dytilum, Foraminifera,* tintinids, polychaetes, copepods, amphipods, shrimp larvae, bivalves, fish eggs, fish scales, molluscs, *Phyrophacus, Pyrocystislunula, Thallasiocera, Thalasiothrix, Melosira, Ornithoceros, cladocera, lieognathids, Acetes,* copepod eggs, digested fish.
S. longiceps	*Coscinodiscus, Pleurosigma, Chaetoceros, Biddulphia, Ceratium, Peridinuim, Protoperidinium, Rhizosolenia, Nitzchia. Fragilaria,* diatoms, copepods, crustacean larvae, amphipods, fish eggs, *Acetus,* tintinids, *Prorocentrum, Oscillotoria, Triceratium, Phyrophacus,* shrimp appendages, *Thallasiocera, Thalasiothrix, Bacteriastrum, Ditylum,* Ornithoceres, *Dinophysis, Planktonella, Navicula, Chaetognaths, Skeletonema, Foraminifera, Polychaetes, Radiolarians, Trichodesmium, Noctiluca*
S. gibbosa	*Copepods*, amphipods, *Pleurosigma, Fragilaria, Protoperidinium*, fish eggs, *Coccinidiscus, Nitzchia,* calanoids, *Skeletonema,* nauplii
S. fimbriata	*Cladocera,* amphipods, *Peridinium, Ceratium, Triceratiium, Prorocentrum, Fragilaria, Coscinidiscus, Foraminifera,* crustacean remains, *Mesodinium*
S. albella	*Ceratium, Peridinium,* amphipods, copepods, *Pleurosigma,* fish eggs, crustacean larvae
E. devisi	*Cladocerans,* amphipods, megalopa, bivalves
S. waitei	*Ceratium, Fragilaria,* cladocera, amphipods, polychaeta, *Peridinium,* crustacean remains, *Coscinodiscus, Skeletonema, Thallasiocera, Pyrophacus*
M. cordyla	*Flatheads,* digested fish
D. russeli	*Acetes* sp., anchovies, squids, shrimps, digested fish.
T. lepturus	*Decapterus* sp., squids, cuttlefish, oilsardine, *Apogon* sp., *S. choprai,* whitebaits, *Acetes* sp., shrimp, crabs, lizardfish, bullseye, *Fistularia* sp. *Therapon* sp. *Bregmoceros* sp., flatheads, *Lagocephalus* sp., digested fish, digested matter
S. nigrofasciata	*N. randalli*, *S. tumbil*, oilsardine, *Leiognathus* sp., *Upeneus* sp., *D. russelli*, shrimps, *Loligo* sp., cuttlefish, digested fish
S. commerson	*S. devisi, M. cordyla*, shrimps, *D. russelli,* digested fish
R. canadum	*S. devisi, N. randalli, S. tumbil, Loligo* sp., digested fish
E. affinis	T. *lepturus, D. russeli, Acetes* sp., lizardfish, *N. randalli, M. cardyla*, digested fish
A. thazard	*Acetes* sp., digested fish
T. albacares	*D. russelli, Loligo* sp., cuttlefish, digested fish
A. rochei	Digested food matter
T. tongol	Squid, digested fish
S. putnamae	*R. kanagurta, S. devisi, D. russelli, M. cardyla, S. longiceps, L. inermis, Leognathus sp., N. japonicus*, squid, digested fish, digested matter
S. obtusata	*S. devisi, Loligo* sp., *D. russelli*, digested fish
S. barracuda	*D. russelli, N. japonicus*, anchovies, digested fish
S. jello	*S. gibbosa, N. randalli*, anchovies, shrimps, *R. kanagurta, S. devisi L. inermis,* oilsardine, *S. undosquamis,* digested fish
C. hippurus	*T. lepturus, Decapterus* sp., Octopus, *M. cordyla,* oilsardine, *L. inermis*, fullbeak, *S. choprai, S. devisi, S. eliptica, S. commersonii,* digested fish
S. commersonianus	*S. longiceps, Lactarius, L. inermis,* anchovies, *R. kanagurta, D. russelli, M. cordyla, Saurida tumbil, Scomberoides* sp., *E. diacanthus,* shrimps, whitebaits, *Loligo* sp., digested fish
S. tol	*S. longiceps, Acetes* sp., anchovies, digested fish
S. tala	*Loligo, D. russelli,* shrimps, digested fish
S. crocodilus	Cod, digested fish

Population/stock parameters of major pelagic resources

Species	L_∞ (cm)	K yr^{-1}	Lm (cm)	M	SSB (t) (% of SS)	SS (t)	Yield (t)	Recruitment nos.
S. longiceps	22.87	0.9	14.9	1.78	69196 (45.6)	151790	91703	15323061
R. kanagurta	31.8	1.11	17.5	2.10	33303 (65.8)	50599	55382	4291531
E. devisi	11.7	1.59	6.8	2.81	1431 (58.5)	2446	3871	3180222
T. lepturus	134	0.82	20.2*	1.671	1467 (81.8)	1793	18840	1614773
S. commerson	162	0.78	70	1.612	172 (53.3)	323	619	49
E. affinis	79.2	0.89	43	1.775	26.8 (44.61)	60.07	86.84	239
A. thazard	49	0.96	Not estimated as sample numbers limited					
A. rochei	42.3	0.61						
T. albacares	211.1	0.27						
T. tonggol	107.5	0.40	49.8					
D. russelli	28.4	0.7	16	1.494	9182 (33)	27209	25643	1924266
M. cordyla	49.6	0.7	24	1.494	1955 (56.8)	3443	3844	100438
S. tol	46	0.98	26	Not estimated as sample numbers limited				
R. canadum	180	0.72	88.5					

*Estimated for anal length

Demersal resources

Demersal group with an estimated catch of 102510 t formed 21.6% of the total catch. Rapid stock classification showed that major demersal resources, except flatfishes were abundant along Karnataka coast. Dominant groups that contributed to the total demersal resources included elasmobranchs (sharks, rays and skates), eels, threadfin breams, lizardfishes and catfish.

Elasmobranchs: An estimated catch of 1058 t of elasmobranchs were landed in Karnataka which formed about 0.22% of the total catch. Catch decreased by 11% when compared to previous year. In Goa 121 t of elasmobranchs were landed during the period showing decrease of 24% from 2013. Sharks formed 49% (520 t), rays 37% (392 t) and skates (guitar fishes) formed 14% of elasmobranch catch in Karnataka.

Relative abundance in terms of catch rate of different species of elasmobranchs in different gears

Sharks	%	Rays	%	Guitar fishes	%
Iago omanensis	18.4	*Himantura bleekeri*	8.8	*R. annandaliei*	65.1
Mustelus sp.	0.1	*H. gerrardi*	0	*R. ancylostoma*	34.9
S. lewini	39.6	*H. imbricata*	7.1		
S. laticudus	16.9	*Mobula japanica*	39.9		
R. acutus	6.9	*P. sephen*	0		
C. limbatus	16.4	*Rhinoptera javanica*	0		
C. sorrah	0.1	Other rays	36.7		
Chiloscyllium griseum	1.1				
Other sharks	0.4				

Sex ratio and size range of sharks, rays and skates

Species	Nos. samples	Size range	Sex ratio
Sharks			
Iago omanensis	235	20-58	1: 1.28
Mustelus sp.	2	58	1:1
Sphyrna lewini	226	18-100	1:1.05
Scoliodon laticaudus	168	18-58	1:1.1
Rhizoprionodon acutus	27	18-109	1: 1.25
Carcharhinus limbatu	103	30-87	1:0.91
Carcharhinus sorrah	2	253-277	1:0
Chiloscyllium griseum	8	64-116	1:3
Rays			
Himantura bleekeri	30	17-90	1:0.88
Himantura gerrardi	38	21-99	1:0.81
Himantura jenkinsii	3	29-70	1:0.5
Mobula japanica	61	20-102	1:0.6
Pastinachus sephen	6	34-77	1:2
Skates			
Rhinobatos annandalei	76	18-78	1:0.81
Rhina ancylostoma	66	20-203	1:1.06

Ray landings at Mangalore

Threadfin breams: In Karnataka, total threadfin bream landing during the period was 44347 t forming 9.4% of the total catch and in Goa it was 1686 t which formed 0.9% in total catch. Trawl was the major gear contributing to threadfin bream fishery with *Nemipterus randalli* being the dominant species (26826 t) contributing 61%, followed by *N. japonicus*.

Juvenile fish landed by bull-trawlers

Whitefish: Total *Lactarius lactarius* landing in Karnataka was 4418 t (0.9%) and in Goa it was 331 t (0.17%) during the period.

Lizardfishes: Total lizardfish landing during the period was 16110 t (3.4%) and 83 t (0.04%) in Karnataka and Goa respectively.

Biological characteristics of important demersal species

Species	Length range (mm)	Mean length (mm)	Sex ratio (M:F)	Immature (%)	Mature (%)	L_m	Major prey items
N. japonicus	60-330	165	1:0.8	52.5	47.5	18.8	Shrimps, Squid, Squilla, Soles, *Bregmaceros*
N. randalli	40-290	128	1:0.7	40.3	59.7	13.4	Shrimps, Squid, Squilla, Soles, *Bregmaceros*
L. lactarius	60-280	141.4	1:0.7	14.2	85.8	13.2	Shrimps, Fish scales, Digested fish
L. inermis	100-500	285	1:1.3	62.2	26.5		Squids, Lizardfish, Fish scales, Digested fish

Population/stock parameters of major demersal resources

Species	L_∞	K yr^{-1}	M	SSB	SS	Yield	Recruitment nos.
N. japonicus	34.5	1.4	2.24	17754	28558	17362	1456928
N. randalli	30.0	1.1	1.97	18572	25873	26283	2079796
L. lactarius	29.5	0.82	1.56	1531	2429	4481	398421

Crustacean resources

An estimated 29233 t of crustaceans were landed forming 6.2% of total catch in Karnataka. Major share of the landings were contributed by trawls. Multiday trawls contributed major share of shrimps and crabs whereas stomatopods were landed only by singleday trawls. Total shrimp landing of Karnataka during the year was 12484 t of which 10839 t was landed by trawlers. Compared to annual average of previous three years, crustacean landings of Karnataka in 2014 showed an increase of 10.3 and among crustaceans crabs showed an increase of 48.8%, stomatopods 11.8% and penaeid shrimps 2.6%.

In Goa an estimated 87404 t of crustaceans were landed forming 4.5% of the total catch. The penaeid shrimp landing was 7969 t of which 2279 t was landed by trawlers

Shrimps: Trawl was the major gear used for penaeid shrimp fishery. Along Karnataka coast, *Metapenaeus monoceros* 3898 t (36%) and *Metapenaeus dobsoni* 3218 t (30%) were the dominant species. *Fenneropenaeus indicus*, *Penaeus monodon, Metapenaeus affinis, Parapenaeopsis stylifera* and *Solenocera choprai* were the other contributors to the fishery.

Biological characteristics of important shrimp species

Species	Length range (mm)	Mean length (mm)	Sex ratio (M:F)	Immature (%)	Mature (%)	Major prey items
M. dobsoni	51-110	76	1:0.95	19.1	29.3	Copepods, Cladocerans, Amphipods
P. stylifera	56-115	72.8	1:0.59	17.2	25.4	Shrimps, Mysids, Amphipods
M. monoceros	86-185	129.4	1:1.21	19.5	40.8	Polychaetes, Molluscs, Fish remains
S. choprai	51-120	86.6	1:0.80	5.9	58.8	Shrimps,crabs, amphipods

Population/stock parameters of important shrimp species

Species	$L\infty$	K Yr^{-1}	Z	M	F	E	Lc
M. dobsoni	119	1.2	5.48	1.42	4.07	0.74	49.4
P. stylifera	123	1.5	4.67	1.6	3.07	0.66	56.48
M. monoceros	193	1.2	4.57	1.2	3.33	0.73	84.32
S. choprai	120	1.2	5.98	1.41	4.57	0.76	54

Resolution of species ambiguity of 'Solar shrimp' of Goa

During late monsoon season (July to August), *Metapenaeus dobsoni* caught along Goa shows visible morphological variations from the species caught off Karnataka and also from the same species caught in Goa during other seasons. Due to the notable differences in the shape of the cephalothorax and abdomen, fishermen of Goa consider this as a 'seasonal native species' locally called as 'solar shrimps'. A study was undertaken to resolve the species status of 'solar shrimps'. Principal component analysis of truss measurements of samples collected from Karnataka and Goa were not significantly different in morphological terms. The samples were tested for their species identity using partial sequences of mitochondrial cytochrome c oxidase subunit1 gene (CO1). The study concluded that the "solar shrimps" are penaeid shrimps belonging to species *Metapenaeus dobsoni* and morphological changes observed during certain seasons could be attributed to environmental influence and food availability which needs to be studied further in detail.

Crabs: Total crab landing of Karnataka in 2014 was 2892 t (1837 t in 2013) and in Goa, it was 299 t (224 t in 2013). Total crab landings of Karnataka increased by 57% and Goa by 34%. Trawl was the major gear used for crab fishery. Along Karnataka coast, three species of edible crabs constituted the fishery i.e., *Charybdis feriatus* 1129 t (46%); *Portunus pelagicus* 718 t (30%) and *Portunus sanguinolentus* 583 t (24%).

Biological characteristics important species of crabs

Species	Length range (mm)	Mean (mm)	Sex ratio (M:F)	Immature (%)	Mature (%)	Major prey items
P. sanguinolentus	56-140	90.3	1:0.79	27.1	59.8	Shrimps, Crabs, Stomatopods
P. pelagicus	61-150	99.6	1:1.71	5	54.7	Shrimps, Crabs, Stomatopods
C. feriatus	51-105	66.3	1:0.91	4.7	83.3	Shrimps, Crabs, Stomatopods

Population/stock parameters of important crab species

Species	L_∞	K yr^{-1}	Z	M	F	E	L_c
P. sanguinolntus	175	1.2	7.17	1.27	5.90	0.82	59.52
P. pelagicus	174	1.6	12.63	1.54	11.09	0.88	59.62
C. feriatus	173	0.88	7.43	1.04	6.39	0.86	48.52

Mollucsan resources

Molluscan landings comprised mainly of cephalopods (cuttlefish, squids, octopus), bivalves (clams, mussels and oysters) and gastropods.

Cephalopods: Cephalopod resources comprising of squids, cuttlefishes and octopus formed 5.64% of the total marine fish production of the state. Production estimated at 26700 t registered 8.57% decrease when compared to 2013. Cephalopods were exploited by multiday trawl fleets (97.36%), singleday trawl fleets (2.51%) and other gears (0.13%). Squids (72.5%) dominated the fishery followed by cuttlefishes (25.5%) and octopus (2%). The Indian squid, *Uroteuthis (Photololigo) duvauceli* (67.1%), and the pharaoh cuttlefish, *Sepia pharaonis* (21.7%) were the major contributors (88.8%) in the cephalopods fishery

Squids: Among squids *U. (P.) duvauceli* formed 92.6% followed by *Loligo edulis* (3.8%) and *Loligo singhalensis* (3.6%). Length range of *U. (P.) duvauceli* in the fishery was 3.5 to 35.5 cm in dorsal mantle length (DML), with mean size at 11.4 cm. Juveniles represented 51% of the annual catch in numbers.

Population/stock parameters of important major squid species

Species	L_r (cm)	L_m (cm)	L_{mean} (cm)	L_∞ (cm)	k	SSB	Yield	ST	E
U.(P.) duvauceli	3.5	11	11.4	42.1	0.9	4,426 t	17,819 t	6166 t	0.68
Sepia pharaonis	6.3	17.1	18.2	42	1.2	1,926 t	5,792 t	2,824 t	0.51

Cuttlefishes: *Sepia pharaonis* (85.0%) was the dominant cuttlefish species, followed by *Sepia elliptica* (6.9%), *Sepiella inermis* (5.1%), *Sepia prashadi* (1.6%) and *Sepia trygonina* (1.3%). *Sepia pharaonis* ranged between 6 cm to 39 cm (DML) and the mean size was 18.2 cm. Juveniles formed 38% of the fishery. Mature individuals were dominant from October to December. Peak recruitment was observed from January to April and in August.

Octopus: *Amphioctopus neglectus* was the dominant species forming 55.5% among octopus species. Size range in the fishery was 1.5 to 10 cm. Pre-spawning females were only encountered in the trawling grounds. Potential fecundity in pre-spawning females was 10173 ± 6070 oocytes. Absolute fecundity ranged from 1070 to 23879 oocytes. Relative fecundity ranged between 62 and 204 oocytes per g body weight. Length of the oocytes ranged between 0.8 and 3.96 mm. Oocyte length frequency distribution of pre-spawning females showed multiple modes, with the initial major peak corresponding to 2 mm oocyte length

Kerala and Lakshadweep

Research Project: FISHCMFRISIL201200300003

Marine fish landings in Kerala during 2014 is estimated at 5.76 lakh t registering a decline of 95000 t i.e.,15% compared to 6.71 lakh t landed during 2013. Landings of all major demersal and pelagic resources declined contributing to an overall decrease of 1.28 lakh t.

Marine fish landings in Kerala during 1985 - 2014

Pelagic finfishes constituted 68%, demersal fishes 15%, crustaceans 9% and molluscs 8% of the total landings during 2014. Pelagic finfish production in the region decreased to 3.91 lakh t from 4.9 lakh t in 2013 because of the reduction in oilsardine landings compared to 2013. A decrease of about 14000 t in the landings of *Stolephorous* spp. was also noticed along Kerala coast. Indian mackerel, tunnies and ribbonfishes were the other major components of the pelagic finfish landings. Demersal resources also witnessed decline in landings which can be attributed to the reduction of about 18000 t of threadfin breams during this period. An upward trend was noticed in the landings of crustacean resources, with an increase of about 9600 t of penaeid shrimps. Molluscan resources increased by about 6000 t, mainly due to increase in squid landings during the year.

Among the commercially important resources, oilsardine showed decrease of about 92000 t. Indian mackerel, penaeid shrimps, cephalapods. tunas and soles recorded increase in landings while threadfin breams, ribbonfishes, *Stolephorous*, seerfishes, pomfrets and barracudas recorded decrease in the landings.

District-wise, Ernakulam contributed the maximum (141090 t), followed by Kozhikode (102318t) . The total fish catch of Malabar regions was 209301 t which accounted for 34.3% of the Kerala landings

Mechanised sector contributed 61% of the landings in 2014, a drastic reduction of about 1.23 lakh t, compared to 2013. Among the mechanised sector, bulk of the landings were by trawlers, purseseiners and ringseiners whereas ringseiners and gillnetters were the major contributors in the motorised sector. The proportion of landings in motorised sector increased from 29% (2013) to 38% in 2014.

Estimated landings of major resources in Kerala

Resource	2013	2014
Oilsardine	246841	155087
Carangids	67387	54445
Mackerel	45829	52053
Cephalopods	44183	48109
Penaeid shrimps	29899	39500
Perches	52380	35867
Anchovies	45344	31557
Ribbonfishes	34223	25828
Tunnies	13053	17719
Flatfishes	12865	13648

Major gears which contributed to the landings were trawlnets, seinenets and gillnets. Multi-day trawl landings accounted for 2.16 lakh t during 2014 which was about 24890 t more than that during 2013, though the catch per hour was 49.17 kg which has decreased noticeably during 2014. The major resources caught in trawlnets were threadfin breams, penaeid shrimps, cephalopods, lizardfishes and ribbonfishes. Ringseine units operated in both mechanised and motorised sectors. Catch from mechanised ringseine showed a drastic decline from 2.04 lakh t in 2013 to 73000 t during 2014. Oilsardine and mackerel were the major contributors in the mechanised sector. Unit operation of mechanised ringseines declined by 50% and that of mechanised purseseine from 1577 to 950.

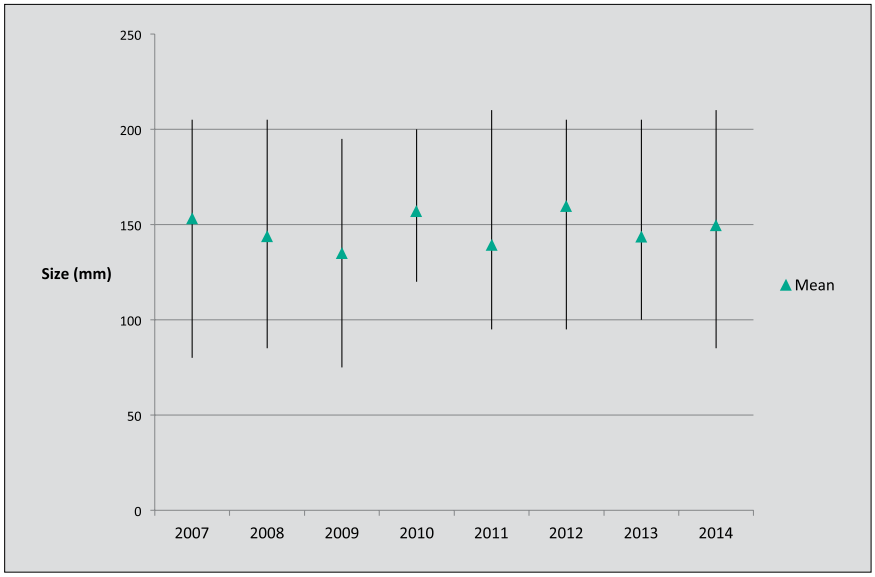
Pelagic resources

Total pelagic fish landing during the year was 380043 t which formed 66% of the states total marine production. Pelagic fishery was supported mainly by sardines, anchovies, other clupeids, mackerel, carangids, ribbonfishes, seerfishes, tunas, billfishes and barracudas. Clupeids including oilsardine contributed 57.4% of the pelagic catch. Other dominant resources were mackerel (13.7%), carangids (14.4%) and ribbonfishes (6.8%). Landings of pelagic resources showed an increase from 2009 to 2012, but declined from 2012 onwards. Contribution of pelagic resources to the total marine production during 2001-2014 varied between 61.7 and 74.2%. Fishery occurred almost round the year with peak during September-October .

Oilsardine: Analysis of fishery during 2002 -2014 shows wide fluctuations in the sardine fishery during the latter part i.e. 2009 to 2014 with a historic rise in landings during 2013 (3.997 lakh t) after which catch drastically declined to 1.5 lakh t in 2014. Taking a district-wise breakup, highest landings was in Kannur in December 2014.

Mackerel: An estimated 52053 t was landed during 2014. Juveniles and young ones were landed by seinenets and bigger sized fishes in spent recovery stages were observed more in gillnet catches.

Whitebaits: Total landing of whitebaits was 31556 t against 45334 t in 2013 and accounted for 5.5% of the total Kerala marine fish production. Whitebaits accounted for 3% of Malabar landings; *Stolephorus devisi* with 52.3% contributed the bulk, followed by *S. commersonii* (31.8 %). *S. waitei*, *S. insularis* and *S. indicus* accounted for 7.9, 4.2 and 3.8% respectively.



Variation in mean length of oilsardine in the fishery during 2007 -2014

Occasionally *S. punctifer* and S. *heterolobus* were also observed in the landings.

Carangids: An estimated 54793 t was landed in Kerala during the year, which formed 14.4% of the total pelagic fish landings of the state. Landings registered a drop of 19.6% in 2014 compared to 2013. Fishery was supported by 34 species, with 11 at commercial level. Scads represented 69.6% of the total carangid production with *Decapterus* spp. dominating the landings contributing nearly 43% of the total carangid catch. Except horse mackerel, all species registered a decline. Young ones of all species were encountered in the trawl and ringseine catches round the year, with peak during southwest monsoon period. Rapid stock assessment of carangids as a whole shows that their stock in Kerala waters remain healthy and at abundant state.

Whitebait catch landed by ringseines at Calicut

Ribbonfishes: Landings during the year declined by 24.5% to 25828 t from the catch of 34223 t in 2013. Fishery was highly irregular with peak during August to November (93% of catch). In central Kerala, two species dominated by *Trichiurus lepturus* supported the fishery. *T. auriga* was encountered in considerable quantities in the deepsea shrimp trawl landings. Rapid stock assessment shows that ribbonfish resource as a whole is in less abundant state. In the Malabar region, ribbonfish fishery was mainly supported by *T. lepturus*. *Lepturacanthus savala* and *Eupleurogramus* muticus were also encountered in stray numbers. Ribbonfish juveniles measuring 191 mm TL (3.1 g) onwards were landed in considerable numbers from May onwards in ringseines.

Seerfishes: Fishery was supported by three species dominated by *Scomberomorus commerson* (88.5%), *S. guttatus* (11.2%) and *Acanthocybium solandri*. *S. guttatus* supported the fishery only along the northern districts of Kerala. It was caught from oceanic waters; the declining trend in the production continued during the year from 3654 to 3480 t. Major share of the production was by hook and line (48.6 %), followed by gillnets (30.4 %) and the rest by ringseine and trawls.

Landings of *S. commerson* was supported by small fishes (22 to 62 cm) in trawl and ringseines. Mean size, length at recruitment (L_r) and length at capture in ring iene/trawls are much smaller than the size at maturity (L_{mat}) and optimum size for exploitation (L_{opt}); whereas these parameters were either very close or slightly larger for the fishes caught in hook and line and gillnets. Length based stock assessment shows that *S. commerson* is overexploited. Rapid stock assessment indicated that the resource is at declining phase necessitating measures for stock revival.

Population parameters of major pelagic species

Species	Size range (cm)	Mean length (cm)	L_{mat}	L_{opt}	L_c	E	Remarks
A. djedaba	9.6-22.3	16.9	13.7	13.8	15.7**	0.44	Under-exploited
S. crumenophthalmus	16-28	19.2	16.7	17	18.2**	0.48	Optimally exploited
M. cordyla	19-38	24.7	25	26	23.6**	0.64	Over-exploited
T. lepturus	43- 96	62.4	47.3	50.9	39.8**	0.58	Over-exploited
S. commerson	22-62**	82.3*	70.1	77.1	74.4* 31.3**	0.68	Over-exploited
	54-110*						
E. affinis	30- 70	46.82	37.7	40.1	40,6*	0.70	Over-exploited
A. thazard	22-40	33.7	27.5	28.8	29.7*	0.48	Under-exploited
A. rochei	16-36	23.9	23.6	24.5	24.9*	0.55	Over-exploited

Tuna: Tuna landings registered an increase of 4666 t i.e., 35.7% compared to 2013. Tuna are landed mainly by drift gillnets and hook and line and to some extent by ringseines. Fishery occurred round the year with peak during August to December. Fishery was supported by eight species of tuna, six at commercial level. Coastal and neritic tuna together constituted 63.8% of the tuna catch and was dominated by *E. affinis* (33.8%). Catch of both coastal and oceanic tuna improved considerably over the previous year. Fecundity (per kg body weight) of *E. affinis* was estimated to vary between 109087 and 114117, *A. thazard* 103122 and 127287 and *A. rochei* 195528 and 239148 eggs. Rapid stock assessment shows that tuna resource is in less abundant state. This necessitates cautious approach to sustain the stock and fishery at the present level.

Vallom operarting ringseine off Alappuzha

Demersal resources

Total demersal fish landings in Kerala in 2014 was 575659 t, registering a decline of 14% from 93797 t landed during 2013. Fishery is constituted by over 19 groups of which the dominant groups are threadfin breams, lizardfishes and elasmobranchs. Sharks, rays, groupers and snappers showed increase in the production.

Elasmobranchs: An estimated 7054 t of elasmobranchs was landed during 2014 forming 1.2% of total marine fish landings and 8.6% of demersal landings of the state. Sharks contributed 61% (4,283 t) of the elasmobranch landings, followed by rays 36% (2538 t), and skates 3% (233 t). More than 30 species were observed in the shark landings by MDNHL (Multiday Non-mechanised Hook and Line) at Cochin with major share by *Carcharhinus falciformis* (35%), *C. longimanus* (12%0), *Sphryna lewini* (8%), *Alopias pelagicus* (9%), *A. superciliosis* (5%), *Galeocerdo cuvier* (6%), *Isurus oxyrinchus* (7%), and *Triaenodon obesus* (6%). Maximum landings of sharks were recorded during January to June.

Rays: An estimated 1893 t of rays was landed during the year with 87% being landed by hooks and line. The major portion of the landings was during June to September. Landings of elasmobranchs were highest in Cochin Harbour followed by Neendakara Harbour in Quilon. Of the different rays landed, *Mobula japanica* was the dominant species contributing 54% of the catch followed by *Himantura fai* (17%), *Taeniurops meyeni,* pelagic sting ray *Pteroplatytrygon violacea*, *Mobula tarapacana*, *Dasyatis microps*, *Rhinoptera javanica* and *Aetomylaeus vespertilio*.

Mobula japanica was seen to mature at 200 cm DW. Maximum landings recorded were in September-November period. In October-November majority of females were late maturing or fully mature. Specimens landed in one boat was observed to be in same stage (Immature/Mature) leading to possible question of aggregation behaviour for breeding purpose. Gill

Shark landings at Cochin Fisheries Harbour

filaments locally called 'flower' fetched high price especially those of *Mobula tarapacana* called 'white' and *Manta birostris* as black.

Threadfin breams: An estimated 23585 t of threadfin breams were landed in all gears combined forming 4.1% of total marine fish landings and 29.05% of total demersal landings of Kerala. Landings declined by 43.82% compared to that of 2013 (41735 t). Maximum catch (6103 t) was recorded during August, immediately following the monsoon trawl ban. Fishery was constituted by two major species during 2014. *Nemipterus japonicus* dominated (53%) followed by *Nemipterus randalli* (47%). The exploitation rate is currently above the optimum level in *N. randalli* (E = 0.62) and *N. japonicus* (E = 0.78). However, since the spawning stock biomass is 82% and 90% for *N. randalli* and *N. japonicus* respectively of the total standing stock, the fishery can be sustained at this exploitation level.

Groupers: Grouper landing during the year was 2763.6 t which contributed 3.39% of the total demersal landings. The landings increased by 34.1% compared to 2013. *Epinephelus diacanthus* dominanted the trawl landings (mostly juveniles) as well as in hook and line (larger specimens). Contribution of *Variola louti*, *Epinephelus longispinis, E. areolatus, E. flavocaeruleus* and *Cephalopholis miniata* to the commercial landings increased during 2014 compared to scant landings in the previous years. The minimum legal size (MLS) estimated for *E. diacanthus* is 180 mm.

Snappers: An estimated 1226 t of snappers was landed contributing 21% of the total landings and 1.5% of the demersal landings. Eleven species of snappers in six genera formed the commercial fishery dominanted by *Lutjanus bohar* (34 %), *Pristipomoides typus* and *Lutjanus gibbus*. Landings of *L. bohar* increased during this year. Other species in the commercial fishery were *Pristipomoides multidens, P. filamentosus, Aphareus rutilans, A. virescens, Lutjanus kasmira, L. lutjanus, L. bengalensis* and *L. rivulatus.*

Flatfishes: An estimated 12318 t of flatfish was landed; catch declined by 4.25% from 2013 and formed 15.17% of the total demersal landings. *C. macrostomus* (78.4 %) remained the most important species in the fishery in all gears followed by *C. macrolepidotus* (10.9%) and *C. bilineatus* (10.7%). Length range of *C. macrostomus* in the fishery was 22 to 178 mm with

recruitment in April-May and November. Fecundity estimated for the species during this period was 22458 to 52487 eggs. The exploitation rate of *C. macrostomus* was estimated to be 0.63. Amphipods and copepods were the most commonly found food component in *C. macrostomus.*

Sciaenids: An estimated 5619 t was landed which formed 6.9% of the demersal landings and 0.89% of the total catch. Landings showed a decline of 5.67% over 2013. Sciaenids are exploited along the Malabar Coast by trawls, gillnet and ringseines. The gearwise contribution showed that highest catch was recorded in the boat seine (870 t) followed by multiday trawlers (667 t), single day trawlers (544 t), ringseines (248 t), gillnets (236 t), outboard nets (98 t) and non-mechanised units (15 t). The catch was highest during the pre-monsoon and post monsoon months.

J. sina (49.57 %) was the dominant species in all the gears. The other important species in the fishery were *Otolithes ruber* (15.19%), *O. cuvieri* (15.28%), *Johnius belangeri* (9.35%), *J. anaeus* (5.44%) and *Nibea soldado* (4.20%) in Malabar region. In Cochin, *Otolithes ruber* (53.66%) was the dominant species in all the gears. Other important species were *Johnius glaucus* (20.22%), *O. cuvieri* (12.05%), *J. belangeri* (5.16%), *N. soldado* (2.28%) and *J. macropterus* (1.35%).

Lizardfishes: Lizardfishes were mainly exploited by trawls (96%). The estimated annual landing of lizardfishes in Kerala in 2014 was 13755 t, which formed 4.8% of the total landings of the state, an increase of 35%, compared to the previous year. Fishery occurred throughout the year with peak landings during the post-monsoon month of August (27.8%), followed by September (23.7%) and October (14.1%). The gearwise analysis of lizardfishes shows that multiday trawlers contributed to the bulk of the lizardfish fishery of the state (89.5%), followed by multiday pair trawlnets (3.2%) and multiday trawlnets with hook and line (3.0%). Small quantities of lizardfishes were landed by outboard boatseine units (1.6%) and non-mechanised boatseine units. The lizardfish fishery was constituted by four species in central Kerala. *Saurida tumbil* dominated (60.0%) followed by *S. undosquamis* (33.7%), *Trachinocephalus myops* (4.10%) and *Synodus englemani* (2.2%). In north Kerala *S. gracilis* was also recorded contributing 4.4% of the total landings. Mature individuals were present throughout the year with peak occurrence during October-December.

Priacanthids landed at Cochin Fisheries Harbour

Priacanthids: An estimated 2388 t of priacanthids was landed during the year and formed only 0.41% of total marine fish landings and 2.93% of the demersal fish landings of the state. Their landings increased

by 21% compared to 2013. *Priacanthus hamrur* (86.6%) and *Cookeolus japonicus* (13.4%) were the species landed.

Pomfrets: During 2014, an estimated 685.5 t of silver pomfrets was landed which formed 0.12% of the total marine fish landings. The landings were mainly contributed by *Pampus argenteus*. A 34% decline was reported compared to the last year. Peak landings was observed during October-December and April-May.

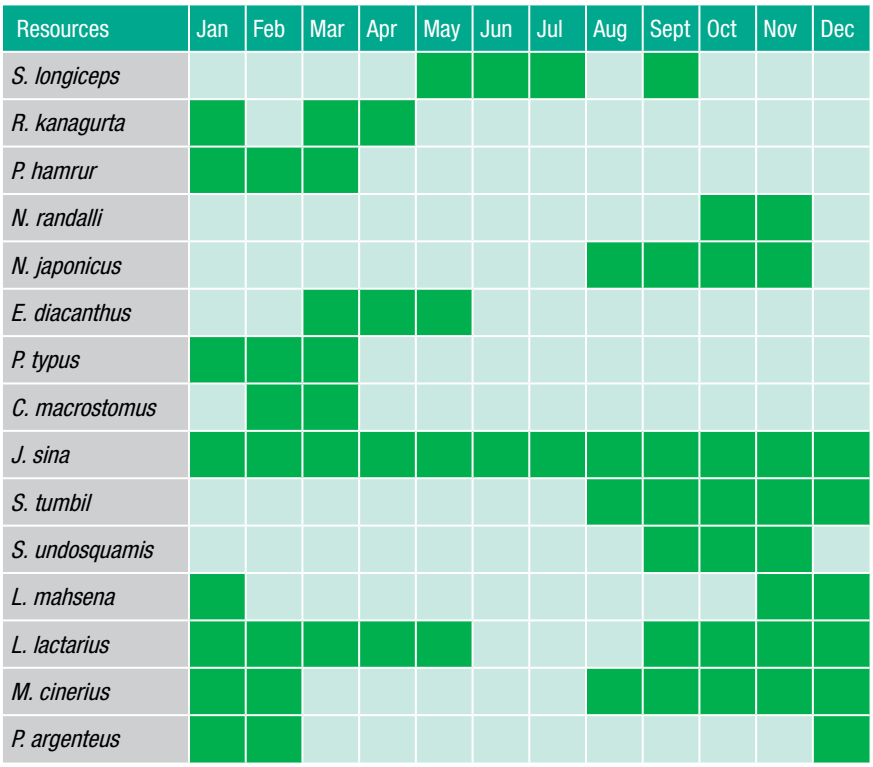
Catfish: A total of 234 t of marine catfishes were landed in Kerala of which 166 t were landed by long lines forming 0.11% of the total landings. *Netuma thalassina* was the only species landed at Cochin Fisheries Harbour.

Pigface breams: The estimated landings of pigface breams during the year 2014 was 433 t, which is marginally higher than that of the previous year (423 t). The fishery is supported by 3 species belonging to the genera *Lethrinus viz., Lethrinus mahsena* (64%), *L. cochyliatus* (21%) and *L. elongatus* (15%). Mature individuals of *L. mahsena* were present throughout the year with peak occurrence during November followed by December and January months. The average annual sex ratio was 1:2 with high predominance of females in the catch.

Whitefish: Estimated landings of whitefish (*Lactarius lactarius*) during 2014 was 0.11% (650.5 t) of the total landings of Kerala. The landing increased by 23% when compared to the previous year. Peak landing was observed in March (12.5%), September (11.5%) and November (17%).

Eels: The estimated landings of eels (*Muranesox* spp.) was 556 t (0.10%) with 14.7% increase when compared to 2013 (474 t). Two species, *Muranesox bagio* (50.5%) and *M. cinerius* (49.5%) contributed to the fishery.

Spawning season of major finfish resources during 2014



Crustacean resources

An estimated 45500 t of shrimps comprising of 39499 t of penaeid and 6001 t of non-penaeid shrimps was landed in Kerala during 2014. Compared to the previous year, landings of the penaeid shrimp increased which can be attributed to an increase in the landings of *Parapenaeopsis stylifera* (47%). Inshore penaeid shrimps contributed 34664 t with MDTN (multiday trawlers) recording a catch of 19877 t and MTN (single day trawler) 6421 t. Region-wise, 36.21% of penaeid shrimps was landed from the southern districts of Kerala, 34.68% from central Kerala and 29% from north Kerala. *M. dobsoni* dominated in all the districts in Kerala except in Kollam where *P. stylifera* recorded a catch of 2345 t compared to 967 t for *M. dobsoni*. The highest catch of *M. dobsoni* was recorded in Ernakulam District (6069 t). Kozhikode recorded the lowest landing of *M. dobsoni* (573 t) and Alapuzha lowest landing of *P. stylifera* (164 t). Modified rapid stock analysis of penaeid shrimp landings for the period 1998 to 2014 of Kerala revealed that they are in the abundant category.

Population/stock parameters of of dominant species of shrimps

Species	L_∞	K	SSB %	Standing stock (t)	Yield/ recruit (kg)	Biomass/ recruit (kg)
M. dobsoni	130	1.8	42	3464	1.846	0.481
P. stylifera	130	1	33	3671	1.025	0.490

During 2014 a total of 3561 t of marine crabs landed in Kerala recording an increase of 43.5% than 2013. Multiday trawlers accounted 68.9% of the catch. Maximum landing was recorded from Kollam District (35%), followed by Kozhikode (34.1%) and Ernakulam (15.4%) districts. Except for Kannur

Landings of deep sea shrimps at Sakthikulangara

and Kasaragod districts, all districts showed increasing trend than the previous year. In the overall catch, *Charybdis feriatus* dominated contributing 38.6%, followed by *Portunus sanguinolentus* (27.9%), *P. pelagicus* (11.1%) and *C. lucifera* (8.1%). *Charybdis nataor* registered a good landing in overall catch of Kerala (5.97%) and 99% of the resource was contributed by Kollam District and rest by Ernakulam District. *Podophthalmus vigil* was recorded exclusively from Kozhikode District which formed 5.77% in overall catch of Kerala this year.

Mortality estimates of commercial crabs along the coast of Cochin during 2014

Species		Z	M	F
Portunus pelagicus	( )	2.48	1.12	1.36
	( )	3.42	1.44	1.99
Portunus sanguinolentus	( )	5.56	1.13	4.43
	( )	5.12	1.30	3.82
Charybsis feriatus	( )	3.33	1.56	1.77
	( )	4.31	1.53	2.78
Charybdis lucifera	( )	3.23	1.44	1.80
	( )	5.63	1.83	3.53

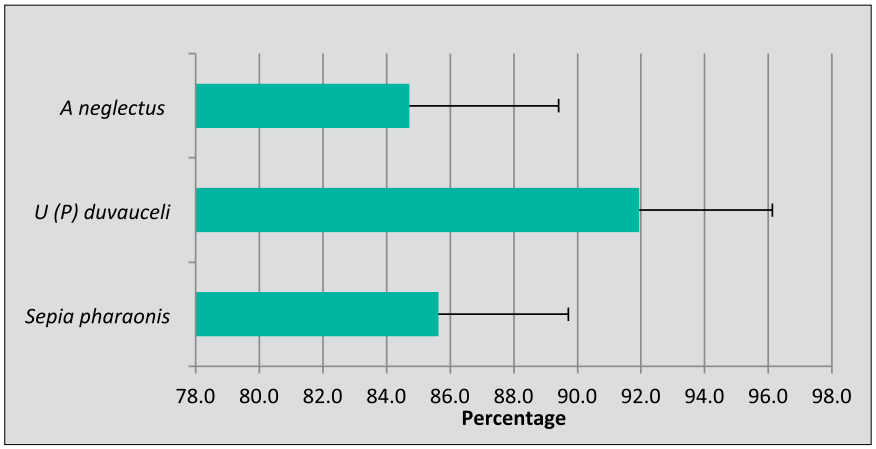
Portunus sanguinolentus landed at Vizhinjam in NMGN (Non Mechanised Gillnet) had a size range of 80 to139 mm with a mean size of 111 mm in males and 103 mm in females. *Panulirus homarus* ranged from 113 to 118 mm. Lobsters were mainly exploited by bottom set gillnets at Vizhinjam.

Molluscan resources

In the Malabar region, total landings of cephalopods was 16806 t. Half of the total landing (50.1%) was contributed by squids, 47.1% by cuttlefishes and 2.8% by octopus. Compared to last year, the contribution of squids decreased from 74 to 50%, while the percentage contribution of cuttlefishes increased from 24.5 to 47.1%. About 70.7% of the total cephalopod landings was recorded in the months of August to November. There was a decrease in the percentage contribution of squids in central Kerala while the percentage contribution of cuttlefish and octopuses showed an increasing trend during 2007-2014. Among squids the main species exploited was *Uroteuthis (Photololigo) duvauceli* followed by *U. (P.) sibogae* and *U. (P.) singhalensis*. Among cuttlefishes, 4 species belonging to the genus *Sepia* were exploited and fishery was dominated by *Sepia pharaonis*. Among octopus, *Amphioctopus neglectus* and *A. marginatus* were most dominant followed by *C. indicus*.

The increase in total production of cephalopods did not correspond to increase in effort. The major gear exploiting cephalopods was trawl (70-80%), while other artisanal gears such as beachseines, hand jigs, lines and gillnets were also in use.

In central Kerala, cephalopods showed maximum abundance during the post-monsoon months of August, September and October with catch rates exceeding 15 kg h^{-1}. During these periods, peak breeding occurs in both cuttlefishes and squids and therefore there exists great danger of recruitment overfishing. *S. pharaonis, U. (P.) duvauceli* and *A. neglectus* stocks were analysed for their mean length in fishery. The major cuttlefish *S. pharaonis* was exploited at 16.7-21.7% below the optimum length of capture (L_{opt}) during 2013 and 2014 which was within the range observed in previous 5 years



Proportion of spawning stock in standing stock of major cephalod resources

(2007-2011). The mean lengths were 11 to 23% less than the L_{opt}. It was closest to L_{opt} in 2013 (16.7%) and farthest in 2014 (21.7%). In case of *U. (P.) duvauceli* also, the mean lengths were marginally below the optimum length of capture. The mean lengths were 19.0 to 29.6% less than the L_{opt} during 2013-2014. It was closest to L_{opt} in 2013 (19.0%) and farthest in 2014 (29.6%).

The dorsal mantle length (DML) of *S. pharaonis* ranged from 45 to 330 mm. Multiple modes were seen in all the months. Peak recruitment to the fishery took place in April and May. Mature females were dominant in September to October indicating peak breeding. In the fishery, *U. (P.) duvauceli* had a size range of 58 to 290 mm. Mature individuals dominated during October -February. *A. neglectus* had a size range of 45 to 80 mm with mature females observed in January and September. Males dominated the fishery throughout the year with peak recruitment in April to June. For *A. neglectus* the annual mean lengths were very close to the L_{opt} during 2013-14.

Present stock status of important cephalopods in central Kerala (RSA)

Species/stock	Historical maximum catch (t)	Recent 3-yr average catch (t)	% of max. catch	Stock status
Sepia pharaonis	23812.6	17836.8	74.9	Abundant
S. prashadi	844.6	347.6	41.2	Declining
S. elliptica	938.9	548.5	58.4	Less abundant
Sepiella inermis	1564.6	873.7	55.8	Less abundant
U. (P.) duvauceli	15698.3	10453	66.6	Less abundant
U. (P.) edulis	6129.8	1508.9	24.6	Declining
U. (P.) singhalensis	4697.7	1508.9	32.1	Declining
Sepioteuthis lessoniana	618.4	245.4	39.7	Declining
Amphioctopus neglectus	5533.3	3230.9	58.4	Less abundant
A. marginatus	2404.3	1636.2	68.1	Less abundant
Cistopus indicus	1737.4	974.0	56.1	Less abundant

Spawning season of major crustacean and molluscan resources during 2014

Resources	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Metapenaeus dobsoni		■	■							■	■	
Parapenaeopsis stylifera			■	■					■	■		
Metapenaeus monoceros		■							■			
M. affinis	■											■
Thenus unimaculatus				■					■	■	■	
Portunus pelagicus	■	■	■	■	■	■	■	■	■	■	■	■
P. sanguinolentus	■	■	■	■	■	■	■	■	■	■	■	■
Sepia pharaonis										■	■	
S. pharaonis	■	■									■	■
U.(P.) duvauceli	■	■								■	■	■
A. neglectus	■								■			

Length range of major resources in the fishery

Species	Length range (mm)/juvenile %
S. longiceps	100 - 210 (14 %)
R. kanagurta	100 - 210 (26 %)
P. hamrur	95 - 405 (9 %)
N. randalli	55 -295 (2 %)
N. japonicus	95 -385 (9 %)
E. diacanthus	85 - 555 (1%)
O. ruber	155 - 315
C. macrostomus	48 -164
P. pelagicus	56 -165 CW
P. sanguinolentus	51 - 160 CW
C. feriatus	46 - 170 CW
C. lucifera	31 - 100 CW
M. dobsoni	56 - 125
P. stylifera	56 - 115
M. monoceros	86 - 180
M. affinis	61 - 165
S. pharaonis	45 - 330 DML
U. (P.) duvauceli	58 - 290 DML
A. neglectus	45 - 80

Peak fishery period of major resources

Resource	Peak fishery
S. longiceps	August-October
R. kanagurta	August-October
A. djedaba	SW monsoon period
S. crumenophthalmus	SW monsoon period
M. cordyla	SW monsoon period
T. lepturus	August-November
E. affinis	August-December
A. thazard	August-December
A. rochei	August-December
N. japonicus	August-December
N. randalli	August-December
Saurida tumbil	August-December
S. undosquamis	August-December
E. diacanthus	August-October/Nov -March
M. japanica	March, Aug -Sept
U.(P.) duvauceli	July -September
U.(P.) singhalensis	July -September

Lakshadweep

The estimated total fish and tuna production was one of the best in the recent years in entire Lakshadweep. Total production was 12185.3 t during 2014 against the total production of 9021.2 t in 2013. Major gears employed during the year were pole and line (single and double pole), troll line, drift gillnet, encircling gillnets (open sea and lagoon-reef types), hand lines (open sea & lagoon-reef types) and long line for octopus fishing. The catch landed by harpoon and castnet were negligible. Total catch during the year increased by 35.1% (3164 t). Tunas formed 92.2% (11231 t) and other fishes and elasmobranchs formed 7.8% (954.0 t). Octopus landings showed an increase during the period of report from all Lakshadweep islands in general and from Agatti, Kavaratti, Androth, Kadamat & Kiltan in particular.

Tuna fishery particularly the surface P&L (pole & line) skipjack fishery recorded remarkable improvement throughout Lakshadweep in 2014. Tuna landings in general (7196.9 to 11231.2 t) and skipjack landings in particular (3684.8 to 7673.2 t) recorded comparatively considerable increase throughout Lakshadweep. This was mainly due to the comparatively better aggregations of skipjack shoals at islands like Minicoy, Andrott, Kalpeni, Suhali, and Bitra. The surface skipjack shoals which were aggregating more around Androth, Kalpeni islands in recent years has almost spread out to entire Lakshadweep during 2014. There was very high aggregation and exploitation of medium and large sized (15-30 kg sizes) yellowfin tunas near Kalpeni/Cheriyam and Androth islands.

The species which supported the tuna fishery were *Katsuwonus pelamis* (68.3%), *Thunnus albacares* (25.7%), *Euthynnus affinis* (4.5%), *Auxis thazard* (1%) and *Gymnosarda unicolor* (0.4%). However *T. albacares* and *A. thazard* catch marginally declined during the year. The decline in the yellowfin catch was mainly due to the reduction in the double pole P&L fishing at Kavaratti and Agatti and the open sea hand lining by the Minicoy fishermen. Pole & line was the most important gear and accounted for 88.1% of the total tuna landings .

Octopus drying in Lakshadweep

Tamil Nadu and Puducherry

Research project: FISHCMFRISIL201200800008

Total marine fish production in Tamil Nadu (TN) during 2014 was estimated at 6.6 lakh t and that in Puducherry at 65933 t. In TN, mechanised trawlers contributed 66.5% of the total landings whereas the contribution by outboard motor operated gillnets was around 14.3%. Other major contributions were from mechanised ringseine 6.6%, outboard motor operated ringseine 2.7% and outboard motor operated hook and line 2.2%. However, the total effort expended in numbers showed that outboard operated gillnets was the most dominant (55.3%) whereas contribution by mechanised trawlnet was only around 11%. Pelagic finfishes formed 46%, demersal finfishes 24%, crustaceans 4% and cephalopod 2%. District-wise landing showed maximum contribution from Ramanathapuram (27%) followed by Kanyakumari (18.2%), Tuticorin (11.6%) and Nagapattinam (11.4%). Oilsardine contributed 12% of the total landing and 24% of the total pelagic finfishes, whereas lesser sardines formed 17% of the total landing and 35% of the pelagic finfishes. In the case of demersal finfishes, sillverbellies formed 13% of the total landing and 44% of the total demersal finfish landing.

Pelagic resources

Sardines: Sardines formed around 29% of the total marine landing and 59% of the total pelagic finfish landing in Tamil Nadu. Other sardines formed 17% in the total catch and 35% in the pelagic finfish catch whereas oilsardine formed 12% in the total catch and 24% in the pelagic finfish catch. Sardine catch by trawl in Tuticorin comprised 6 species, *Sardinella gibbosa* (77.1), *S. longiceps* (90.4%), *S. albella* (6.1%) *S. fimbriata* (0.2%), *Amblygaster clupeoides* (8.3%) and *A. sirm* (7.8%). In Chennai, it was dominated by *S. longiceps* (92.1%) followed by *S. gibbosa* (7.9%). In Mandapam, the resource comprised of *S. gibbosa* and *S. albella* of which the former dominated in Gulf of Mannar and in Palk Bay by *S.longiceps* (61.4%) in addition to *S. gibbosa* (19.8%) and *S. albella* (18.8%). Oilsardine was landed by Mechanised ringsiene (MRS) 50%, trawl (31%), outboard bagnet (OBBN) 98%, outboard ringsiene (OBRS) 7% and outboard motor operated gillnet (OBGN) 4%.

Mackerel: The landing was estimated at 18378 t forming 2.86% of the total catch and 5.8% among pelagic finfish. The dominant species was *Rastrelliger kanagurta* but the fishery in Chennai included *R. saughni* (22%) also. Indian mackerel was landed mainly by OBGN (56 %), trawlers (20%) and MRS and OBRS 7% each.

Tunas: Total tuna landing was estimated at 14004 t. Tuna catch in drift gillnet fishery at Tuticorin comprised of eight species *T. albacares* (34.8%), *K. pelamis* (33.3%), *E. affinis* (23%), *A. thazard* (6.2%), *A. rocheii* (1.2%), *T. tonggol* (1.1%), *S. orientalis* (0.4%) and *G. unicolor* (0.1 %). In Chennai, the tuna fishery comprised *T. albacares* (31.9%), *K. pelamis* (22.7%), *E. affinis* (16.6%) and *A. thazard* (28.8 %).

Carangids*:* Total production of carangids was estimated at 31332 t. Carangid fishery in trawl was composed of 7 geera - *Decapterus* spp. (40.6%)*, S. leptolepis* (28.7%), *Caranx* spp. (17.1%)*, S. crumenophthalmus* (4.2%), *Alectis* spp. (6.9%), *M. cordyla* (0.4%) and *Scomberoides* spp. (0.3%). In hook and line, the fishery was comprised of *Scomberoides* spp. (41.9%), *Caranx* spp. (37.4%) and *Elegatis bipinnulata* (5.1%).

Seerfish: Total seerfish landing was 6137 t, composed of *Scomberomorus commerson, S. guttatus*, *S. lineolatus* and *Acanthocybium solandri*. Drift gillnet fishery at Tuticorin comprised *S. commerson* and *A. solandri* whereas *S. commerson* and *S. lineolatus* formed hook and line fishery. In Chennai, *S. commerson* and *S. guttatus* were the dominant species in the fishery.

Billfishes: Billfish landing was estimated at 748 t, landed mainly by MGN. The fishery comprised of *Istiophorus indica* (76.8 %), *Xiphias gladius* (16.1%), *Istiophorus platypterus* (5.6%) and *Tetrapterus* sp. (1.6%) in Tuticorin.

Demersal resources

Silverbellies: It is the most important demersal finfish fishery resource in TN forming around 13% of the total landing and 43.8 % of the total demersal finfish landing. Landed mainly by mechanised trawlers. *Eubleekeria jonesi, Karalla dussumieri, Leiognathus brevirostris, Gazza minuta, K. daura, Secutor ruconius, Deveximentum insidiator, Photopectoralis bindus, Eubleekeria splendens, L. lineolatus and L. equulus* formed main species and in Mandapam Palk Bay, *K. dussumieri* formed the dominant species contributing 59%. In Gulf of Mannar, *E. jonesi* (68%) was the dominant species. In Chennai and Tuticorin also, *K. dussumieri* contributed 32 and 33% respectively.

Pigfacebreams: Total production was 11351 t which formed 1.8% of the total landing in Tamil Nadu. The important species forming the fishery were *Lethrinus lentjan* (43.7%), *L. nebulosus L. miniatus* (11.7%), *L. ramak* (5.1%) and *L. ornatus* (4.5%).

Nemipterids: The landing was 10542 t and the major species that formed the fishery were *N. japonicus* (57.3%), *N. randalli* (25.8%), *N. bipunctatus* (14.6%) and *N. peronii* (2.3%) in Chennai. In Tuticorin, nemipterid catch was comprised of *Scolopsis bimaculata* (53.2%) *N. randalli* (13.3%), *S. vosmeri* (12.%) and *N. japonicus* (11.4%). About 93% was landed by mechanised trawlers.

Snappers: Snappers formed 0.6% of the total production in Tamil Nadu and the fishery comprised mainly of *Lutjanus lutjanus, L. fulvus, Pristipomoides filamentosus, Lutjanus ehrenbergii, L. indicus, L. fulviflamma, L. madras, L. quinquelineatus*. It was landed by trawlers (64%), OBGN (12%) and outboard hook and line (OBHL) 23%.

Goatfish: Formed 1.4% of the total landing and the catch mainly consisted of *Upeneus supravittatus, U. moluccensis, U. bensasi, U. sundaicus, U. sulphureus, U. tragula, U. taeniopterus, U. vittatus, Parupeneus indicus, P. heptacanthus.* Trawlers landed 83% followed by OBGN (14%).

Croakers: The fishery was comprised by *Otolithes ruber, Kathala axillaris, Nibea maculata, Johnius carutta, J. dussumieri, Pennahia anea, Protonibea diacanthus, Johnieops dussumieri, Dendrophysa russelli, Nibea soldado* and *Panna microdon.* Croakers formed 2% of the total landing. Around 35% was landed by trawlers, 54% by outboard motor operated gillnet (OBGN) and outboard motor operated hook and line (OBHL).

Lizardfishes: Formed 0.8% of the total landings and 2.7% of the total demersal finfish landing. *Saurida tumbil, S. undosquamis* and *Trachinocephalus myops* were the species landed.

Landing of *Charybdis smithii* at Tuticorin

Groupers: Total grouper landing was only 1962 t which was around 0.3% of the total landing in Tamil Nadu, Species being *Epinephelus malabaricus, E. undulosus, E. bleekeri, E. merra, E. coioides, E. fasciatus, E. aerolatus, E. latifasciatus, E. radiatus, E. longispinis, Cephalopholis sonnerati, Cephalopholis* sp. OBHL was the dominant gear contributing 58% followed by trawlers (23%) and OBGN (15%).

Pomfrets: Total landing was 3268 t and the fishery comprised of *Parastromateus niger, Pampus argenteus and Pampus chinensis* of which *P. argenteus* formed 79%.They were landed mainly by trawlers. Chinese pomfret was landed only in Cuddalore, Chennai and Tiruvallur.

Catfishes: Formed 0.9% of the total landing and 3% of the demersal finfish landing. Catfishes were landed mainly by trawlers (59%) and OBGN (26%). Catch in Chennai comprised *Netuma thalassina, Plicofollis tenuispinis, P. dussumieri, Arius arius, A. maculata, Plotosus lineatus, P. canius* and *P. limbatus*

Crustacean resources

In Tuticorin, *Penaeus semisulcatus* and *Fenneropenaeus indicus* dominated the shrimp fishery. In general, *Portunus sanguinolentus* and *P. pelagicus* dominated the crab fishery at Tuticorin. There was targeted fishery for the deepsea crab, *Charybdis smithii* by the deep sea trawlers especially during October to December due to slump in the catch of quality fishes. The monthly CPUE of this species ranged from 0.3 t to 6.3 t with an average CPUE of 3.7 t.

Species composition of commercially important inshore shrimps at Tuticorin

	TFH	Vempar	Mottaigopuram	Punnaikayal	Manappad	Periathazhai
Species	Trawl	Trawl	Thallumadi	Gillnet (Estuarine)	Gillnet	Gillnet
P. semisulcatus	96	42.5	89	3	36	95
F. indicus	1.9		10.6	93	64	5
Melicertus latisulcatus	1.6	3.1	0.01			
M. canaliculatus		0.03				
Penaeus monodon				3		
Parapenaeopsis maxillipedo	0.3	15.6				
P. stylifera		0.2				
Metapenaeus moyebi	0.01	0.1	0.2	0.01		
M. dobsoni	0.0001		0.3	0.001		
M. elegans	0.005					
M. monoceros			0.0005			
Metapenaeopsis stridulans	0.001	1.1	0.0003			
M. mogiensis	0.01	0.9	0.0002			
M. toloensis		9.2				
M. hilarula		0.8				
Megokris granulosus	0.05	12.6	0.001			
M. sedili	0.02	6.3				
Trachysalambria curvirostris		7.5				
Alpheus rapacida	0.0001	0.1				
Solenocera pectinulata		0.1				
Nikoides maldivensis		0.1	0.0004			

Species composition of commercially important crabs at Tuticorin

	TFH	Vempar	Mottaigopuram	Punnaikayal	Manappad	Periathazhai	Tharuvai kulam	Vellapatti
Species	Trawl	Trawl	Thallumadi	Gillnet (Estuarine)	Gillnet	Gillnet	Gillnet	Gillnet
Charybdis smithii	93							
Portunus sanguinolentus	4	66	10	51	97	87	52	
Charybdis natator	1.3	14	14	7	1	12	18	17
Portunus pelagicus	1	17	47	36	2	0.01	19	77
P. haani	0.6	2		2	0.3		9	
Charybdis feriatus	0.01		0.1	0.5	0.1	1		0.2
C. lucifera	0.001		0.1	0.03		0.2		
Portunus petreus	0.03							
Scylla sp.	0.005			3		0.1		1
Thalamita integra			28.3	0.1				
Charybdis affinis			0.2					

Species composition of commercially important lobsters

Species	TFH	Manappad	Periathazhai	Kayalpattinam	Chinnamuttom	Colachel
	Trawl	Gillnet	Gillnet	Gillnet		
Panulirus ornatus	44	1	6	42	5.8	0.8
P. homarus	38	98	92	53	92	99.2
P. versicolor	19	1	2	5	0.5	
Thenus unimaculatus					1.7	

Cephalopod resources

In Gulf of Mannar and Palk Bay, the cuttlefish *Sepia pharaonis* dominated whereas in Chennai, the dominant species was *Sepiella inermis*

Species composition of cuttlefishes

Species	Chennai	Gulf of Mannar	Palk Bay
Sepia pharaonis	17.3	81.3	69.5
S. aculeata	14.4	18.5	30.4
Sepiella inermis	31.5	0.2	0.1
S. prashadi	10.9		
S. brevimana	25		

The size composition studies showed that the mean size of almost all the resources were above the minimum legal size.

Size composition of dominant pelagic resources (cm)

	Chennai		Mandapam		
Species	Min	Max	Min	Max	Mean
S. longiceps	9.3	20.2			
S. gibbosa	9.3	15.3	10.5	15.0	13.0
S. albella			8.5	14.5	12.0
S. indicus	7.8	15.6			
R. kanagurta	13.1	27.8	17.0	27.0	22.3
R. faughnii	16.2	24.8			
T. lepturus	30.6	76.2			
S. commerson	16.0	72.0			
S. guttatus	28.0	57.0			
E. affinis	24.0	53.0			
K. pelamis	36.0	70.0			
T. albacares	5.0	105.0			

Size composition (mm) of dominant demersal resources

Chennai	Min	Max	Mean
N. japonicus	70	269	158.4
N. randalli	80	209	133.6
N. bleekeri	80	239	140.9
O. ruber	90	309	171.4
J. carutta	100	209	132.3
N. maculata	100	229	154.6
S. undosquamis	110	259	179.1
Mandapam			
P. podophthalmus	40	200	120.6
N. maculata	90	230	140
Karalla dussumieri	50	140	94
E. jonesi	30	130	83.5
U. sundaicus	80	180	123.5
U. tragula	80	200	135.6
Tuticorin			
Parupeneus indica	122	340	
G. minuta	60	135	102.9
L. lentjan	170	400	243

Size composition of shrimps (mm) at Tuticorin

Trawl-TFH	Size range	mode	Mean
P. semisulcatus	96-225	146-150	149
M. latisulcatus	111-210	156-160	158
P. maxillipedo	51-100	66-70	70
M. sedili	36-85	46-50	50
M. stridulans	61-80	61-65	69
M. mogiensis	46-80	56-60	61
F. indicus	111-115	141-145	132
M. granulosus	46-85	51-55	59
M. moyebi	61-95	66-70	69
A. rapacida	66-75		
M. elegans	86-105	101-105	98
M. dobsoni	76-80		78
Plesionika quasigrandis	46-115	76-80	80
P. investigatoris	66-105	91-95	85
Aristeus alcocki	96-115		
Solenocera hextii	76-130	116-120	104
Heterocarpus woodmasoni	66-100	76-80	81
H. gibbosus	46-120	76-80	78
Penaeopsis jerryi	76-90	81-85	84
Parapenaeus fissuroides	71-105	81-85	84
Metapenaeopsis andamanensis	56-95	81-85	78
M. coniger	71-95	86-90	86

Size composition of crabs (mm) from trawl at Tuticorin

Species	Size range	mode	Mean
C. smithii	36-80	51-55	58
C. natator	46-130	66-70	78
P. sanguinolentus	66-135	96-100	99
P. haani	56-105	66-70	75
P. petreus	61-80		71
C. lucifera	76-80	76-80	78
C. feriatus	91-95	91-95	93

Size composition of lobsters (mm) from gillnet at Tuticorin

		TL	CL
Species		Range	Mean
P. ornatus	Male	110-380	218
	Female	160-405	254
P. homarus	Male	80-210	153
	Female	110-220	165
P. versicolor	Male	150-220	187
	Female	155-290	228

Size composition of cephalopods (mm) from Chennai

Species	Male		Female	
	Min	Max	Min	Max
S. pharaonis	50	110	55	105
S. aculeata	45	110	50	100
S. prashadi	38	95	48	110
S. brevimana	42	100	17	90
S. inermis	40	96	43	100
U. duvauceli	50	165	50	165
U. singhalensis	60	285	60	170
L. uyii	45	80	55	80
O. dolfusi	100	320	140	310
O. membranaceous	170	300	110	345

Size composition of cephalopods (mm) from Palk Bay (PB) and Gulf of Mannar (GM)

Species	From	Min	Max	Mean
S. aculeata	PB	40	180	106
	GM	50	150	90.8
S. pharaonis	PB	90	300	180.9
	GM	80	380	248.7
S. lessoniana	PB	90	250	154
	GM	90	360	172

Peak spawning season of dominant pelagic resources were found between January and June. In the case of demersal resources, it was between January and May and between October and December. In shrimps at Tuticorin, peak spawning season was July to November and in crabs, between February and April and July to August.

Peak spawning period of dominant pelagic resources at Tuticorin

Species	Spawning season	Peak
R. kanagurta	Throughout	Jan-Jul & Nov
S. gibbosa	Jan-Aug	Feb-Mar
S. indicus	Throughout	Jan-Mar
T. albacares	Almost throughout	Jan-Mar
K. pelamis	Throughout	Jan-Jun
E. affinis	Throughout	Mar-May

Peak spawning period of demersals at Chennai

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Nemipterus japonicus												
Nemipterus randalli												
Nemipterus bipunctatus												
Otolithes ruber												
Johnius carutta												
Nibea maculata												
Saurida undosquamis												
Eubleekeria splendens												
Gazza minuta												

>60% of the fishes were ripe/spawning
30-60% of the fishes were ripe/spawning
10-30% of the fishes were ripe/spawning
<10% of the fishes were ripe/spawning

Rapid stock assessment showed that out of the major 11 resources analysed, 7 were abundant, three less abundant and only one resource (*P. chinensis*) was in declining state. In Puducherry, out of the 9 resources studied, 5 were in abundant condition, 3 in less abundant and one in declining stage

Rapid stock assessment of 11 major species in Tamil Nadu for the period 2002-2014

	Historic		Recent	% of	
Species	Maximum	Year	Average	maximum	Status
S. longiceps	143168	2011	122128	85	Abundant
R. kanagurta	27769	2011	18381	66	Less Abundant
T. lepturus	17252	2011	10292	60	Less Abundant
A. solandri	92	2009	52	57	Less abundant
S. commerson	7136	2003	6041	85	Abundant
S. guttatus	288	2010	450	156	Abundant
E. affinis	7483	2006	8109	108	Abundant
K. pelamis	1724	2010	1767	103	Abundant
P. niger	817	2004	692	85	Abundant
P. chinensis	132	2010	35	26	Declining
P. argenteus	2122	2007	3157	149	Abundant

Rapid stock assessment of 9 major species in Puducherry for the period 2002-2014

Species	Historical maximum	Year	Recent average	% of maximum	Status
S. longiceps	6879	2004	3662	53	Less abundant
T. lepturus	239	2010	440	184	Abundant
P. niger	77	2006	77	100	Abundant
P. argenteus	13	2010	147	1131	Abundant
R. kanagurta	2660	2004	1691	64	Less abundant
S. commersoni	746	2007	505	68	Less abundant
S. guttatus	38	2010	37	97	Abundant
E. affinis	559	2008	97	17	Declining
K. pelamis	218	2010	266	122	Abundant

Seerfish landing at Tuticorin

Andhra Pradesh

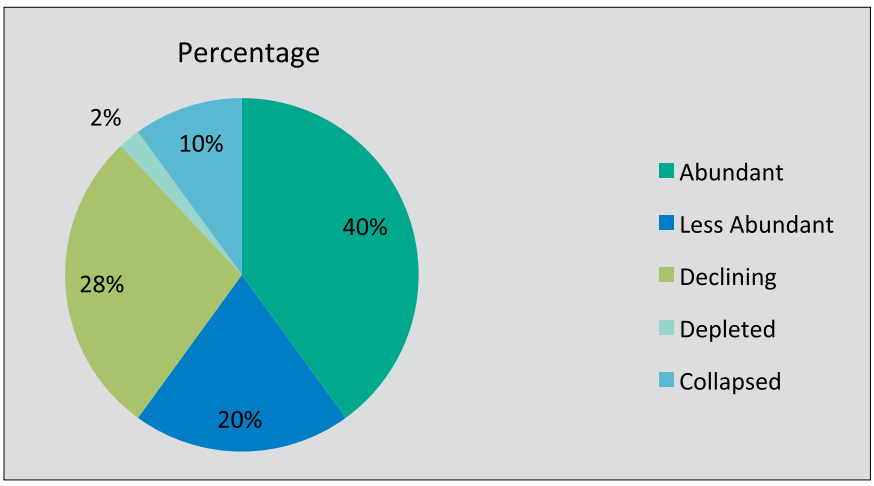
Research Project: **FISHCMFRISIL201201100011**

Andhra Pradesh recorded an all time high (since 1985) marine fish landings of 3.42 lakh t. Pelagic groups contributed 67%, demersals 21%, crustaceans 11% and molluscan resources formed 1% of the landings in 2014. Mechanised trawls formed the largest contributor to marine landings of the state (39%) followed by seinenets (26%) and gillnets (19%). Catch rates were highest in seinenets which landed 658 kg unit^{-1}, followed by hook and lines which landed 146 kg unit^{-1}, gillnets 109 kg unit^{-1} and mechanised trawls 34 kg h^{-1}.

Major groups landed along Andhra Pradesh in 2014 were Indian mackerel (16%), other sardines (12%), penaeid shrimps (8%), ribbonfish (6%), croakers (4%) and *Thryssa* sp. (4%).

Rapid stock assessment of marine fish stocks

Rapid stock assessment (modified) indicated that the marine stocks of Andhra Pradesh are in healthy state. Of the total 59 groups/stocks, 40 stocks were in the abundant phase, 20 were less abundant, 28 were declining, two were depleted and 10 had reached collapsed phase. Of the 30 pelagic groups, 7 were in the abundant phase, 9 were less abundant, 10 were declining and 4 had reached the collapsed stage. The major collapsed stocks were that of *Tenualosa ilisha* (hilsa shad) and mullets. Of the 23 demersal groups, 14 were abundant, 3 were less abundant, 4 were declining and 2 had collapsed. The collapsed stocks were that of pigface breams, *Lethrinus* spp. and the unicorn cod, *Bregmaceros* sp. Of the 5 crustacean groups, 2 were abundant and 3 were declining. Among molluscs, only cephalopod status was studied and this resource was abundant.



Stock status of marine fishery resources of Andhra Pradesh

Pelagic resources

Groups that dominated pelagic landings were clupeids (0.88 lakh t, 25.9%), mackerel (0.56 lakh t, 16.3%), tunas and billfishes (0.30 lakh t, 8.7%), ribbonfishes (0.20 lakh t, 5.9%), carangids (0.19 lakh t, 5.5%), and seerfishes (0.08 lakh t, 2.3%). Among clupeids, the major contributors were lesser sardines contributing 0.40 lakh t, oilsardine contributing 0.14 lakh t, *Thryssa*

Shoreseining operation at Kondarajupalem, Andhra Pradesh

0.13 lakh t and *Stolephorus* 0.07 lakh t. *Rastrelliger kanagurta* formed almost the entire mackerel landings, the rest being formed by *Rastrelliger faughni*. Carangids landed were contributed by horse mackerel (27.9%), scads (15.8%), leatherjackets (7.5%) and other carangids (48.9%). Seerfish catch was shared by *Scomberomorus commerson* (46.5%) and *Scomberomorus guttatus* (53.6%). Among tuna, the dominant species landed were *Euthynnus affinis* (38.6%), followed by *Thunnus albacares* (26.3%), *Katsuwonus pelamis* (25.5%) and *Auxis thazard* (9.6%). The landings of billfishes and barracudas for the year were 0.02 lakh t each.

Demersal resources

Major groups that contributed to demersal landings were perches (14327 t, 19.6 %), sciaenids (12936 t, 17.7 %), pomfrets (7836 t, 10.7 %), goatfish (7831 t, 10.7 %), silverbellies (6516 t, 8.9 %) and catfish (6109 t, 8.4 %). Among the major demersal resources, threadfin breams were almost exclusively caught by mechanised trawlers (97%). Major species of threadfin breams landed by mechanised trawls were *Nemipterus japonicus* (53.4%), *N. randalli* (35.2%), *N. bipunctatus* (9.1%) and *N. nematophorus* (2.3%). Sciaenids were landed mainly by mechanised trawlers (49.0%), gillnets (22.1%), seines (12.5%) and artisanal gears (12.0%). The major species landed were *Otolithes ruber* (30.6%), *Pennahia anea* (26.5%), *Johnius carutta* (13%) and *Nibea maculata* (12.8%). An estimated 7,836 t of pomfrets were landed in the state during 2014. The landings of *Parastromateus niger* was 4,449 t, *Pampus argenteus* was 2,961 t and that of *Pampus chinensis* was 426 t. Mechanised trawls landed 65% of pomfrets. An estimated 6,516 t of silverbellies were landed

Clupeids landed by a motorised Theppa

Seerfish landed at Visakhapatnam

with 3,468 t (53.2%) being landed by mechanised trawls alone. An estimated 7,831 t of goatfish was landed in the state of which 6,307 t (80.5%) were landed by mechanised trawls alone. An estimated 6,109 t of catfish were landed in the state with 4,125 t (67.5%) being landed by mechanised trawls. Major species of catfish landed were *Netuma thalassina* and *Plicofollis tenuispinis*.

Crustacean resources

Crustacean landings were dominated by penaeid shrimps (27542 t, 76%), crabs (7004 t, 20%) and non-penaeid shrimps (481 t, 1.4%). Among penaeid shrimps the major species landed were *Metapenaeus monoceros* (16.3%), *Metapenaeus dobsoni* (11.9%), *Fenneropenaeus indicus* (11.7%), *Penaeus monodon* (9.1%) and *Penaeus semisulcatus* (5.1%). The major crab species landed were *Portunus sanguinolentus*, *Portunus pelagicus* and *Charybdis feriatus*.

Molluscan resources

Molluscan landings of the state were dominated by cuttlefish (1601 t, 62%) and squids (996 t, 32%). Major cuttlefish species landed were *Sepia pharaonis* (45%), *S. aculeata* (47%), *Sepiella inermis* (5%) and other species (3%). Among squid, the dominant species were *Uroteuthis (Photololigo) duvauceli* (95%) and *Uroteuthes (Photololigo) singhalensis* (5%).

Biology of major species

Sardine: Total length of oilsardine, *Sardinella longiceps* at Visakhapatnam ranged from 70 to 229 mm with an annual mean of 156.9 mm. The annual sex ratio was 1:1.3. Males dominated the catch in June and December while females dominated in July to November and January to February. Juvenile fishes were only caught during November and December. July to September is the peak breeding season of oilsardine with another spawning during February. This is substantiated by the presence of high proportion of spawners and by high gonadosomatic index (5.7) in these months. Food component analysis in gut revealed an abundance of planktonic matter. Empty or trace amounts of food in stomach was encountered in most fishes. Feeding intensity was highest in February. Length of *Sardinella fimbriata* and *Sardinella gibbosa* ranged from 40 to 194 mm and 135 to 189 mm with respective modes at 62 mm and 172 mm.

Mackerel: Length of Indian mackerel, *Rastrelliger kanagurta* at Visakhapatnam ranged from 70 mm to 239 mm with an annual mean of 180.6 mm. Annual sex ratio was 1:1.7. Males dominated the catch in February to March and August while females in rest of the months. August appears to be the peak breeding month followed by February with many females in mature condition and high gonadosomatic index values of 6.87 and 5.47. Average fecundity was 137500 with ova diameter varying from 0.19 to 0.48 mm. Analysis of food components revealed an abundance of copepods, decapods, ostracods, *Coscinodiscus*, foraminifera along with minute quantities of cladocerans, fish eggs and larvae, zoea, tintinnids and nematods. Feeding intensity revealed most of the individuals to have stomachs ¼ to ½ filled. Highest feeding intensity was in April. Length of *Rastrelliger faughni* ranged from 170 to 254 mm with mode at 202 mm.

Ribbonfish: *Trichiurus lepturus* was the major species with size ranging from 240 to 959 mm and having mean length of 562.2 mm. Annual sex ratio was 1:1.9. Males dominated the catch during February, March and August, whereas females dominated in rest of the months. Mature females were encountered in high numbers in April-July and again in February. Highest GSI % of 5.95 was observed in July. Average fecundity was 77016 with ova diameter ranging from 0.25 to 0.77 mm. High IRI values of sardines, *Stolephorus*, mackerel, scad and digested fish imply that they were the principal food constituents of *T. lepturus*. Near to half of the fishes had their stomachs either empty or had trace amounts of food material in it. Feeding intensity was higher during July to September.

Tuna: Length of skipjack tuna, *Katsuwonus pelamis* at Visakhapatnam ranged from 300 to 719 mm with an annual mean of 513.2 mm. Annual sex ratio was 1:1.6 with male domination in June, July and November and female domination in February. Mature females were encountered in June, July, September and November. Average gonadosomatic index was 2.5. Feeding intensity was higher in June and July. Length of yellow fin tuna, *Thunnus albacares* at Visakhapatnam ranged from 180 to 1659 mm with an annual mean of 644.9 mm. Annual sex ratio was 2.1 with male domination in September and November and female domination in January and June. Mature females were encountered in September. Feeding intensity was higher in June, September and November. Cephalopods were their preferred prey, followed by *Selar* sp. and other carangids.

Seerfish: Length of *Scomberomorus guttatus* at Visakhapatnam ranged from 220 to 599 mm with an annual mean of 401.4 mm. Annual sex ratio was 2.2 with female domination in all the months. Feeding intensity was high in September and January. *Stolephorus* sp. and sardine were the principal food components encountered in their gut. For *Scomberomorus commerson*, length varied between 320 to 1529 mm with annual mean of 772.2 mm. Highest mean length of 1113.1 mm was recorded in June and lowest of 515 mm in August.

Barracuda: Length of *Sphyraena jello* at Visakhapatnam ranged from 280 to 1,219 mm with an annual mean of 601.6 mm. Annual sex ratio was 1:5.4 with female domination in all months. Mature females were encountered in September. Average GSI % was 2.8. Average fecundity was 170500 with ova diameter ranging from 0.27 to 0.30 mm. Feeding intensity was higher in February. The high IRI values of *Stolephorus*, sardine and myctophids imply them to be the principal food constituents.

Dolphinfish: Length of *Coryphaena hippurus* ranged from 420 to 1119 mm with mean of 734.4 mm. Highest mean length of 863.8 mm was recorded in January and lowest 627.1 mm was recorded in July. Carangids, frigate tuna and suckerfishes were the principal food items encountered in their gut.

Cobia: Mean length recorded for *Rachycentron canadum* was 525.1 mm with length varying from 240 mm to 939 mm. Highest mean length of 586.7 mm was recorded in July and the lowest mean length of 393.3 mm in August.

Flatfish: The Indian halibut *Psettodes erumei* ranged from 163 to 597 mm with weight ranging from 52 to 3053 g. Mean size was 340 mm and the sex ratio was 1.4. Of the females observed, 54.7 % were mature. Fish was the predominant diet component.

Threadfin breams - *Nemipterus randalli* ranged in length from 99 to 265 mm with weight ranging from 5 to 94 g. Mean size was 141 mm and the sex ratio was 1.14 and 69.3% of female fish were mature. Fish and shrimps were the main diet components.

Croakers: *Nibea maculata* ranged in length from 92 to 201 mm with weight ranging from 6 to 90 g. Mean size was 132 mm. sex ratio was 1.2 and 97.5% of female fish were mature. Main diet components were fish, shrimps and crabs.

Catfish: Size of *Netuma thalassina* ranged from 116 to 850 mm with weights ranging from 27 to 5.678 kg. Mean size was 392 mm and mean weight, 929 g. Sex ratio was 1.1 indicating slight dominance of female fish in the samples. Main diet components were fish, crab, stomatopods and shrimps.

Penaeid shrimps: Size range of male *Meptapenaeus dobsoni* contributing to the fishery was 58 to 117 mm with modal class of 83 to 87 mm and that of females was 63 to123 mm with modal class 98 to102 mm. The annual sex ratio was 1:1.94 Size range of *Meptapenaeus monoceros* males in the fishery was 63 to 151 mm with modal class of 120 to 130 mm and females ranged from 57 to 202 mm with modal class 160 to170 mm. Annual sex ratio was 1:3.9.

Dry fish for sale at Visakhapatnam Fishing Harbour

Crabs: Size range of *Portunus sanguinolentus* males contributing to the fishery was 83to 173 mm with modal class of 105 to 125 mm. Size range of females was 83 to -163 mm with modal class 120 to 140 mm. Annual sex ratio was 1:1.55., The major diets were fish, shrimps, crabs and squid.

Cuttlefish: Size range of male *Sepia aculeata* contributing to the fishery was 9.7 to 25.6 cm with modal classes of 12.0 to 12.9 and 13.0 to 13.9 cm. Mean size was 14. 66 cm. Size range of females was 6.8 to 19.6 cm with modal class 16.0 to 16.9 cm and 17.0 to 17.9 cm. Mean size was 15.76 cm. Annual sex ratio was 1:0.86 and females dominated throughout the year. Of the females 59.21% were in mature condition. Diet of *S. aculeata* comprised of mostly digested fish, fish parts such as scales and bones, digested shrimps and crabs. Size range of male *Sepia pharaonis* in the fishery was 10.5 to 30 cm with mean size of 17.6 cm and modal class of 15 and 15.9 cm. Size range of females was 11.0 to 25.4 cm with mean size of 17.1 cm and the modal class of 16 and 16.9 cm. Sex ratio was 1:0.54. About 81.77 of the females were in mature condition. Diet of *S. pharaonis* comprised of mostly digested shrimp, crabs, whole fishes, digested fish, scales and bones.

Squid: Size range of male *U.(P.) duvauceli* contributing to the fishery was 6.2 to 17.5 cm with mean size of 9.88 cm and modal class of 9-9.9 and 10 to 10.9 cm. Size range of females was 5.8 to 17.7 cm with mean size of 9.64 cm and the modal class of 7 to 7.9 and 8to 8.9 cm. Sex ratio was 1:0.81. About 49.62% of the females were in immature condition. Diet of *P. duvauceli* comprised of mostly digested shrimp (*Acetes* sp.), digested fish, scales and bones.

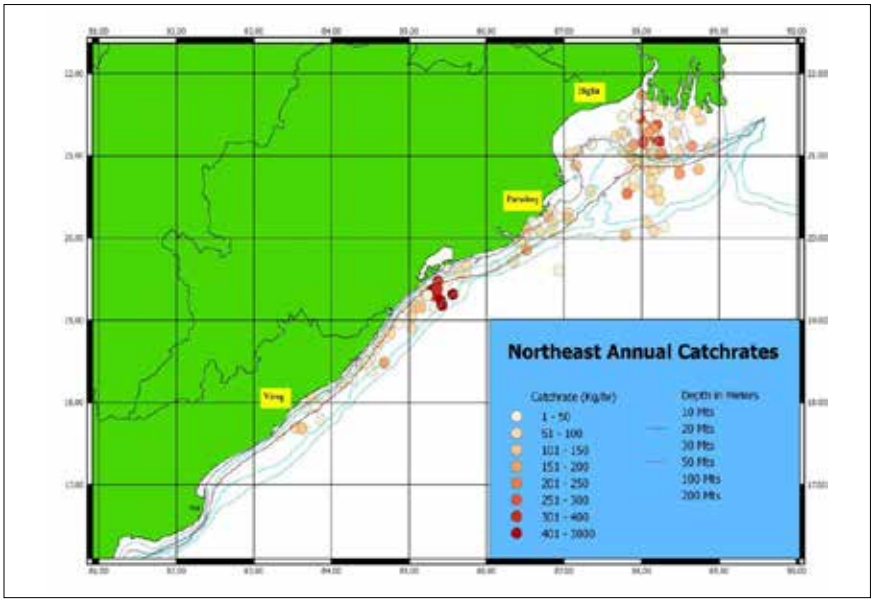
Fish being dried onboard trawler

Trawl fishery of the northeast coast

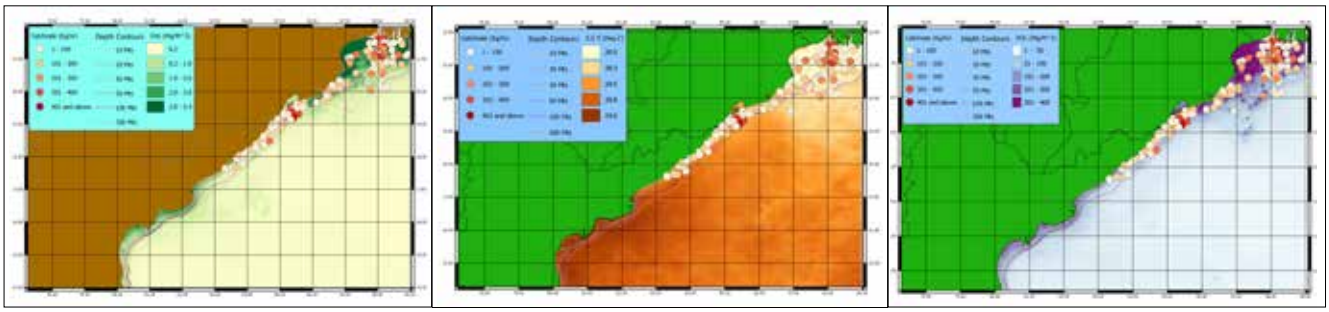
Research Project: FISHCMFRISIL201203200032

Total production by trawlers during 2014 along the northeast coast of India was 2.39 lakh t, registering a decrease by 26 % when compared to 3.25 lakh t in 2013. Catch rate in 2014 was 39.31 kg h^{-1}, while in 2013 it was 33.68 kg h^{-1}. Trawl landings in Andhra Pradesh was 1.34 lakh t forming 39.2% of the total marine landings. Overall catch rate was 34.1 kg h^{-1}, for the state. Contribution by sona boats to the trawl landings was 99.2% and the contribution of small mechanised trawlers was 0.8%. Catch rate in sona boats was 34.1 kg h^{-1}, and in small mechanised trawlers it was 38.1 kg h^{-1}. Though catches were similar to that of previous year; catch rates increased by 35%. In Odisha, trawl catch was 0.89 lakh t forming 64.4% of the annual marine fish catch. Overall catch rate in Odisha was 53.2 kg h^{-1} and 93% of the catch was contributed by multiday trawlers and 7% by singleday trawlers. Catch rate in multiday trawlers was 51.5 kg h^{-1} and in singleday trawlers it was 94.0 kg h^{-1}. Catch was same as of last year, while catch rates declined by 5%.

In West Bengal, 0.16 lakh t was landed by trawlers at catch rate of 33.2 kg h^{-1} forming 20.6% of the total marine landings. There was a drastic reduction in



Catch rates of trawls along the north-east coast of India with underlying bathymetry



Catch rates of trawls, with chlorophyll, particulate organic carbon and SST of seawater along the north-east coast of India

catch by 84% when compared to last year (1.02 lakh t). Catch rates however, have decreased only marginally by around 10%. This implies that fishing effort in 2014 was very low, possibly because of reduced catche, increasing operational costs and frequent occurrence of inclement weather conditions.

Catch composition of trawl landings

Andhra Pradesh	Odisha	West Bengal
Penaeid shrimps (16.9%)	Croakers (18.6%)	Croakers (14.1%)
Ribbonfishes (12.2%)	Penaeid shrimps (15.0%)	Penaeid shrimps (8.3%)
Rastrelliger kanagurta (6.9%)	Ribbonfishes (12.9%)	*Thryssa* (7.2 %)
Threadfin breams (5.0%)	Non-penaeid shrimps (4.7%)	Silverbellies (6.7%)
Croakers (4.7%)	Mackerel (4.0%)	Goatfishes (6.6%)
Goatfishes (4.7%)	*Coilia dussumieri* (3.4%)	*Megalaspis cordyla* (5.3%)
Stolephorus (4.4%)	*Harpadon nehereus* (3.0%)	*Coilia dussumieri* (4.6%)
Crabs (3.7%)	*Megalaspis cordyla* (2.5%)	Lesser sardines (4.2 %)
Lizardfishes (3.8%)	*Setipinna* (2.5%)	Threadfin breams (3.9%)
Catfishes (3.1%)	Catfishes (2.3%)	*Setipinna* (3.3%)
Silverbellies (2.6%)		Ribbonfish (3.1%)
Scads (2.0%)		

Biology of dominant species landed by trawls at Visakhapatnam and Digha

	Length range (mm)		Mean length (mm)		Sex ratio		Mature %		GSI	
Species	Vizag	Digha	Vizag	Digha	Vizag	Digha	Vizag	Digha	Vizag	Digha
Rastrelliger kanagurta	70-239	170-219	180.6	193.4	1.7	1.5	5.6	31.9	3.1	4.4
Sardinella longiceps	70-229	140-219	156.9	181.2	1.3	1.2	16.6	10.8	4.4	6.1
Trichiurus lepturus	240-959	480-879	562.2	599.5	1.9	3.3	18.8	17.1	4.3	3.6
Otolithes ruber	140-419	140-459	276.3	261.2	2.2	2.0	38.7	55.5	2.9	3.6
Nemipterus japonicus	80-289	140-319	176.8	194.7	3.1	1.6	32.7	47.7	2.9	3.2
Urotuethis (Photololigo) duvauceli	55-179	65-139	94.9	88.4	1.0	0.6	47.3	34.5	12.0	10.5
Saurida undosquamis	120-419		241.6		4.5		47		4.8	
Upeneus vittatus	100-209		154.4		2.5		42.5		3.8	
Metapenaeus monoceros	55-202		133.7		4.1		33.9		11.7	
Upeneus sulphureus		120-189		SSS267.0		2.0		15.4		3.4
Cynoglossus arel		140-289		219.4		1.4		9.8		5.8
Penaeus monodon		119-241		174.6		1.4		17.8		8.2

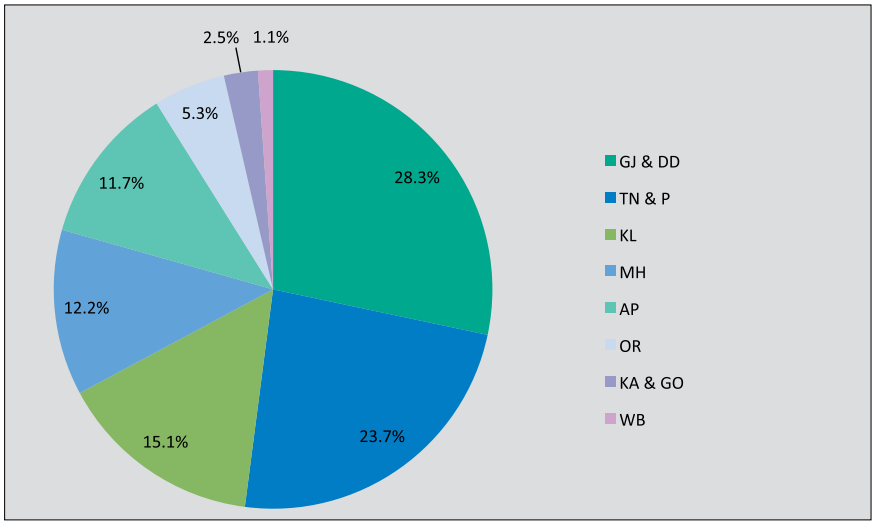
Elasmobranch resources

Research Project: FISHCMFRISIL201200500005

Elasmobranch landings along the Indian coast are being monitored at 4 centres in Gujarat, 3 centres in Maharashtra, 2 centres in Karnataka, 7 centres in Kerala, 8 centres in Tamil Nadu and 1 centre in Andhra Pradesh. Collection of data on catch statistics in terms of quantity of elasmobranchs landed (by weight) by different gears, enumeration of large elasmobranchs landed, cataloging of all available species in the Indian waters, confirmation of taxonomic status, documentation of biology and population characteristics of different species, assessment of vulnerability status and awareness generation among fishermen communities on the need to conserve this resource are the focal areas being addressed.

Fishery

Production of elasmobranchs in India in 2014 was to the tune of about 47242 t, with trawlnets accounting for 46.1%, gillnets 34.2%, hook & line units, 4.6%, dolnets, 3.1% and seines and bagnets, 0.2%. Landings improved marginally by 0.4% from the previous year. Mechanised sector contributed 77.7% of the elasmobranch landings while motorised and non-mechanised sectors contributed 21.7 and 0.6% respectively. Sharks formed 42.5% of the total elasmobranch landings, skates (guitar fishes), 4.8% and rays, 52.7%. Gujarat, Daman & Diu accounted for 28.3% of the elasmobranch landings, Tamil Nadu & Puducherry, 23.7%, Kerala, 15.1%, Maharashtra, 12.2%, Andhra Pradesh, 11.7%, Odisha, 5.3%, Karnataka & Goa, 2.5% and West Bengal, 1.1%.



State-wise percentage contribution to elasmobranch landings in India-2014

Species composition

Rays dominated elasmobranch landings during 2014, forming 50.7% while sharks formed 43.4% and skates, 5.9%. Sharks were the dominant group in Karnataka & Goa, Gujarat & Daman-Diu, Maharashtra and Kerala, while rays were dominant in, Tamil Nadu & Puducherry, Andhra Pradesh, Odisha and West Bengal. Skates did not form a fishery in Odisha.

Sharks were represented by members of the families Carcharhinidae, Triakidae, Sphyrnidae, Echinorhinidae, Hemiscylliidae, Alopiidae, Lamnidae,

Centrophoridae, Squalidae and Stegostomatidae. The ray fishery was constituted by members of Dasyatidae, Mobulidae, Myliobatidae, Gymnuridae and Rhinopteridae. Skates landed along the coast mostly belonged to families Rhinidae and Rhinobatidae.

State-wise profile of elasmobranch fishery during 2014

Gujarat, Daman & Diu: An estimated total of 13388 t of elasmobranchs were landed in Gujarat, Daman & Diu during 2014, registering an increase of 17.9% from the previous year. Sharks contributed 71% of the elasmobranch landings of the state followed by rays contributing 19.1% and skates 9.9%. Major species of sharks were *Scoliodon laticaudus, Rhizoprionodon oligolinx* and *Rhizoprionodon acutus.*

Maharashtra: An estimated total of 5779 t of elasmobranchs were landed in Maharashtra during 2014, registering an increase of 5.6% from the previous year. Sharks contributed 82.7% of the total elasmobranch landings of the state followed by rays 14.2% and skates 3.1%. Major species of sharks were *S. laticaudus, R. oligolinx, R. acutus, Carcharhinus macloti, Carcharhinus leucas, Carcharhinus sorrah, Carcharhinus limbatus, Lamniopsis temmincki* and *Sphyrna lewini.* The ray fishery was dominated by *Himantura bleekeri, Himantura gerrardi, Himantura alcocki* and *Himantura imbricata*, and skate fishery by *Rhynchobatus djiddensis*, *Glaucostegus (=Rhinobatos) granulatus* and *Rhinobatos annandalei*.

Karnataka & Goa: An estimated total of 1183 t of elasmobranchs were landed in Karnataka & Goa during 2014, registering a decrease of 11.6% from the previous year. Sharks contributed 52.9% of the elasmobranch landings of the state followed by rays contributing 34.6% and skates 12.4%. Major species of sharks were *C. limbatus, S. laticaudus, S. lewini* and *Mustelus* sp. The ray fishery was dominated by *Dasyatis microps, H. bleekeri, H. gerrardi,* and *H. imbricata*, and skate fishery by *Rhinobatos obtusus, R. annandalei* and *Rhina ancylostoma*.

Kerala: An estimated total of 7054 t of elasmobranchs were landed in Kerala during 2014, registering an increase of 36.6% from the previous year. Sharks contributed 60.2% of the elasmobranch landings of the state followed by rays contributing 36.6% and skates 3.2%. Major species of sharks were *Carcharhinus falciformis, Carcharhinus longimanus, Isurus oxyrinchus, Galeocerdo cuvier, Alopias pelagicus, Alopias superciliosus* and *S. lewini.* Other important species landed were *C. limbatus*, *C. leucas, Carcharhinus brevipinna, Carcharhinus amblyrhynchoides, C. sorrah, Carcharhinus albimarginatus, Prioncace glauca, Stegostoma fasciatum, Echinorhinus brucus, Nebrius ferrugineus, Triaenodon obesus* and *Loxodon macrorhinus.* The dominant species of rays were *Mobula japanica, Himantura fai* and *Taeniura meyeni. Pteroplatytrygon violacea, Mobula tarapacana, Dasyatis microps, Rhinoptera javanica, Himantura uarnak, H. jenkinsii, H. gerrardi*, and *Neotrygon kuhlii* were the other important ray species landed. *Gymnura poecilura, Aetobatus flagellum* and *Pastinachus* sp. were also landed in small numbers. Among skates, the dominant species were *Rhina ancylostoma,*

Tamil Nadu & Puducherry: An estimated total of 11198 t of elasmobranchs were landed in Tamil Nadu & Puducherry during 2014, registering a decrease of 18.3% from the previous year. Sharks contributed only 3.4% of the elasmobranch landings of the state while rays contributed 90.3%

and skates 6.3%. Major species of sharks were *C. falciformis, C. limbatus* and *Rhizoprionodon acutus.* Dominant species of rays were *H. gerrardi, H. imbricata* and *G. poecilura*. The guitarfish *Rhinobatos schlegelli* formed a good fishery during the year.

Andhra Pradesh: An estimated total of 5515 t of elasmobranchs were landed in Andhra Pradesh during 2014, registering an increase of 8.8% from the previous year. Sharks contributed 25% of the elasmobranch landings of the state while rays contributed 71.53% and skates 3.5%. Major species of sharks were *Iago* spp., *S. lewini*, *Chiloscyllium griseum*, *C. falciformis*, *C. brevipinna* and *C. limbatus*. Rays were dominated by *G. poecilura*, *H. gerrardi*, *H. uarnak*, *N. kuhlii*, *R. javanica* and *Torpedo* sp. while skates were dominated by the guitarfishes *R. obtusus* and *R. granulatus*.

Odisha: An estimated total of 2496 t of elasmobranchs were landed in Odisha during 2014, registering an increase of 55.6% from the previous year. Sharks contributed 39% of the elasmobranch landings of the state while rays contributed 61%.

West Bengal: An estimated total of 527 t of elasmobranchs were landed in West Bengal during 2014, registering a steep decline of 85.4% from the previous year. Sharks contributed 42% of the elasmobranch landings of the state while rays contributed 57% and skates, 1%.

Biological studies are being carried out on all the major species of sharks, rays and guitarfishes landed along the Indian coast. Based on data collected during the period 2012-2014, biological indices have been estimated for some sharks, rays and skates of common occurrence in the fishery along the Indian coast.

Fully grown young ones of *Rhizoprionodon acutus*

Shark landings at Sassoon Dock, Mumbai

Biological indices of selected species of elasmobranchs of common occurrence in India's shark landings

Species	Length range in fishery (cm)	Mean length in fishery (cm)	Sex ratio	Lm50 Female (cm)	Number of young ones
Carcharhinus falciformis					
Cochin	55-255	145.8	1:1.1		8-14
Chennai	59-83	70	1:0.3		
Visakhapatnam	73-163				
Carcharhinus limbatus					
Mumbai	57-210	150	1:1.01	165	1-10
Mangalore	30-87	75.7	1:0.9		
Calicut	52-218	135	1:1.2		
Cochin	167-256	194.83	1:1.25		5-7
Chennai	77-80	79	1:0		
Carcharhinus longimanus					
Cochin	95-265	160	1:2		
Carcharhinus macloti					
Mumbai	32-92	74.8	1:1.1	62	
Carcharhinus sorrah					
Mumbai	74-253	150	1:1	130	1-8
Mangalore	253-277	265	1:0		
Chennai	72-89	76	1:0		
Chiloscyllium arabicum					
Mumbai	49-57		1:0.5		
Chiloscyllium griseum					
Mangalore	64-116	72.1	1:3		
Galeocerdo cuvier					
Veraval	9-39	23.1	1:1		
Cochin	107-205	160.8	1:1.4		12 -30
Visakhapatnam	83-142				
Iago omanensis					
Veraval	36-73	48			2-20
Mangalore	20-58	44.5	1:1.2		8-16
Iago sp.					
Visakhapatnam	27-57	40	1:7		1-13
Chennai	45-57	46.5	1:3	45	6-11
Lammiopsis temmincki					
Mumbai	57-175	1:1.1	145		
Mustelus sp.					
Visakhapatnam	28-85	54		39	6-25
Mangalore	50-60	58	1:1		
Chennai	37-51	41.7	1:1.3	41	17-25
Rhizoprionodon acutus					
Veraval	26-81	62.1	1:2		2-6
Mumbai	27-92	68.2	1:0.9	59	2-8
Mangalore	18-109	53.2	1:1.3		
Chennai	57-65	61	1:2		
Rhizoprionodon oligolinx					
Veraval	36-93	62.2	1:2.8	54	2-7
Mumbai	34-78	62	1:1.5	55	

Mangalore		18-109	53.2	1:1.3		
Scoliodon laticaudus						
Veraval		26-63	46.2	1:1.3	33	2-14
Mumbai		18-54	37.1	1:1.1	35	
Mangalore		18-58	40.5	1:1.1		
Chennai		21-52	27	1:1.4	35	1-14
Sphyrna lewini						
Mumbai		54-101		1:0.7		
Mangalore		18-100	63.2	1:1.05		
Cochin		85-260	155.6	1:0.6		16-22
Chennai		120-210	135			12-24
Visakhaptanam		51-135				
Gymnura poecilura						
Visakhapatnam		19-86	49.8	1:1.5	40	1-6
Mumbai		41-85	1:1.5	1:1.5		
Chennai		32-60	49.2	1:3	42	3
Hmantura bleekeri						
Mumbai		24-101		1:1	28	
Mangalore		17-90	49.8	1:0.9		
Himantura gerrardi						
Mumbai		22-111		1:0.9		
Mangalore		21-99	48.2	1:0.8		
Chennai		21-33	29.9	1:5		
Himantura imbricata						
Mumbai		13-29	22.4	1:1.1	20	1-2
Chennai		11-29	18.6	1:1.1	18	5-7
Himantura jenkinsii						
Mangalore		29-70	55.1	1:0.5		
Chennai		15-110	56.4	1:0.8	70	
Himantura walga						
Veraval		39-121	52.7	1:1.8		
Mobula japanica						
Mangalore		20-102	50.1	1:0.6		
Pastinachus sephen						
Mumbai		65-91		1:3		
Mangalore		34-77	51	1:2		
Rhina ancylostoma						
Mangalore		20-203	92.8	1:1.1		
Rhinobatos annandalei						
Veraval		42-63	55.2	1:2.5		
Mangalore		18-78	56.3	1:0.8		
Glaucostegus (= Rhinobatos) granulatus						
Mumbai		85-95		1:0.5		
Rhinobatos schlegelii						
Chennai		13-75	34.1	1:0.5		6-18
Rhinobatos variegatus						
Vizhinjam	M	45-80	62.8		58.6	
	F	42-90	73.2		43.5	

Minimum Legal Size (MLS) of capture was estimated for *R. oligolinx, H. imbricata, H. jenkinsii* and *G. poecilura*. The recommended sizes which correspond to the Minimum Size at Maturity (MSM) are 53 cm TL, 14 cm DW, 61 cm DW and 29 cm DW respectively.

Endangered/Protected species

Accidental catche of one sawfish, *Pristis microdon* (4.0 m in length, matured male) and one whale shark, *Rhincodon typus* (juvenile, 3.5 m), both

Whale shark (3.5 m TL) Satpati, Maharashtra

Large tooth sawfish (4 m TL) Satpati, Maharashtra

Protected elasmobranchs accidentally landed during 2014

listed under Schedule II of the WPA (1972) were observed in the month of November and December respectively at Satpati, Palghar District in Maharashtra. Accidental catch of *R. typus* (1.5 m length and 175 kg) was observed at Tuticorin Fishing Harbour in August 2014.

Export of devil ray gill plates

Chennai and Cochin continue to be major hubs for processing and export of devil ray gill plates. With the inclusion of the giant manta ray *Manta birostris* and the smaller reef manta ray *Manta alfredi* in Appendix II of CITES w.e.f. September 2014, there is growing concern over this rampant trade.

Processed gill plates of devil rays

Shark conservation awareness programmes

Awareness programmes were initiated to popularise the need for shark conservation in the country. The first awareness meet was held at Satpati in Maharashtra on 8 August, 2014. Pamphlets on shark conservation in Marathi were distributed to the stakeholders.

Barcoding of elasmobranchs

Research Project : EF-3/MoES

Elasmobranch samples were collected from Cochin Fisheries Harbour, Colachel, Thoothoor, Muttom, Vizhinjam, Chennai, Mandapam and Tuticorin. Among these landing centres, maximum landings of elasmobranchs were recorded at Cochin Fisheries Harbour, from where majority of the samples were collected. During the period, a total of 49 species of elasmobranchs were collected comprising 24 species of sharks, 21 species of rays and 4 species of skates. Detailed morphometric measurements and photographs of the specimens were taken for identification of the species. Tissue samples were taken from the fins of the specimens for barcoding studies using mitochondrial COI gene. Actual location of fishing was ascertained from enquiry and a distribution map was prepared.

Order	Family	Species
Hexanchiformes	Hexanchidae	*Heptranchias perlo*
Squaliformes	Echinorhinidae	*Echinorhinus brucus*
Lamniformes	Alopiidae	*Alopias pelagicus*
	Alopiidae	*Alopias superciliosis*
	Lamnidae	*Isurus oxyrinchus*
	Lamnidae	*Isurus paucus*
	Pseudocarchariidae	*Pseudocarcharias kamoharai*
Orectolobiformes	Ginglymostomatidae	*Nebrius ferrugineus*
	Stegostomatidae	*Stegostoma fascitatum*
Carcharhiniformes	Triakidae	*Mustelus mosis*
	Triakidae	*Iago omanensis*
	Carcharhinidae	*Carcharhinus falciformis*
	Carcharhinidae	*Carcharhinus brevipinna*
	Carcharhinidae	*Carcharhinus limbatus*
	Carcharhinidae	*Carcharhinus longimanus*
	Carcharhinidae	*Carcharhinus leucas*
	Carcharhinidae	*Galeocerdo cuvier*
	Carcharhinidae	*Loxodon macrorhinus*
	Carcharhinidae	*Triaenodon obesus*
	Carcharhinidae	*Carcharhinus melanopterus*
	Carcharhinidae	*Carcharhinus albimarginatus*
	Carcharhinidae	*Prionace glauca*
	Carcharhinidae	*Rhizoprionodon acutus*
	Sphyrnidae	*Sphyrna lewini*

Genebank submissions

Zacharia, P.U., Dhaneesh,K.V., Shiyas,C.A., Kishore,T.G., Rekha Nair, J., Sobhana,K.S., Vijayan,K.K., Sandhya,S. and Pradeep, M.A. *Alopias pelagicus* voucher CMFRI-DFD-AP-08 COI gene, partial cds; mitochondrial GenBank: KJ475205.1

Zacharia, P.U., Dhaneesh,K.V., Shiyas,C.A., Kishore,T.G., Rekha Nair, J., Sobhana,K.S., Vijayan,K.K., Sandhya, S. and Pradeep, M.A *Galeocerdo cuvier* voucher CMFRI-DFD-GC-05 COI gene, partial cds; Mitochondrial GenBank: KJ475202.1

Zacharia, P.U., Dhaneesh, K.V., Shiyas, C.A., Kishore, T.G., Rekha Nair,J., Sobhana, K.S., Vijayan,K.K., Sandhya,S. and Pradeep, M.A *Himantura fai* voucher CMFRI-DFD-HF-04 COI gene, partial cds; mitochondrial GenBank: KJ475201.1

Zacharia, P.U., Dhaneesh, K.V., Shiyas, C.A., Kishore, T.G., Rekha Nair, J., Sobhana, K.S., Vijayan, K.K., Sandhya, S. and Pradeep, M.A. *Himantura gerrardi* voucher CMFRI-DFD-HG-03 COI gene, partial cds; mitochondrial GenBank: KJ475200.1

Zacharia, P.U., Dhaneesh, K.V., Shiyas, C.A., Kishore, T.G., Rekha Nair, J., Sobhana, K.S., Vijayan, K.K., Sandhya, S. and Pradeep, M.A. *Mobula japanica* voucher CMFRI-DFD-MJ-01 COI gene, partial cds; mitochondrial GenBank: KJ475198.1

Zacharia, P.U., Dhaneesh, K.V., Shiyas, C.A., Kishore, T.G., Rekha Nair,J., Sobhana, K.S., Vijayan, K.K., Sandhya, S. and Pradeep, M.A. *Mobula tarapacana* voucher CMFRI-DFD-MT-02 COI gene, partial sequence; mitochondrial GenBank: KJ475199.1

Zacharia, P.U., Dhaneesh, K.V., Shiyas, C.A., Kishore, T.G., Rekha Nair, J., Sobhana, K.S., Vijayan, K.K., Sandhya, S. and Pradeep, M.A. *Mustelus mosis* voucher CMFRI-DFD-MM-06 COI gene, partial cds; mitochondrial GenBank: KJ475203.1

Zacharia, P.U., Dhaneesh, K.V., Shiyas, C.A., Kishore, T.G., Rekha Nair,J., Sobhana, K.S., Vijayan, K.K., Sandhya, S. and Pradeep, M.A. *Sphyrna lewini* voucher CMFRI-DFD-SL-09 COI gene, partial cds; mitochondrial GenBank: KJ475206.1

Zacharia, P.U., Dhaneesh, K.V., Shiyas, C.A., Kishore, T.G., Rekha Nair, J., Sobhana, K.S., Vijayan, K.K., Sandhya, S. and Pradeep, M.A. *Triaenodon obesus* voucher CMFRI-DFD-TO-07 COI gene, partial cds; mitochondrial GenBank: KJ475204.1

In rays, the collected samples belonged to the order Myliobatiformes

Order	Family	Species
Myliobatiformes	Dasyatidae	*Dasyatis zugei*
	Dasyatidae	*Himantura fai*
	Dasyatidae	*Himantura gerrardi*
	Dasyatidae	*Himantura imbricata*
	Dasyatidae	*Himantura uarnak*
	Dasyatidae	*Himantura marginata*
	Dasyatidae	*Himantura jenkinsii*
	Dasyatidae	*Dasyatis centroura*
	Dasyatidae	*Taeniura meyeni*
	Dasyatidae	*Neotrygon kuhlii*
	Dasyatidae	*Pteroplatytrygon violacea*
	Dasyatidae	*Pastinachus sephen*
	Dasyatidae	*Pastinachus gracilicaudus*
	Gymnuridae	*Gymnura poecilura*
	Myliobatidae	*Aetobatus narinari*
	Myliobatidae	*Aetomylaeus vespertilio*
	Myliobatidae	*Aetobatus flagellum*
	Myliobatidae	*Rhinoptera javanica*
	Mobulidae	*Mobula japanica*
	Mobulidae	*Mobula tarapacana*
	Mobulidae	*Manta birostris*

In skates, the collected samples were mainly from the order Rajiformes

Order	Family	Species
Rajiformes	Rhynobatidae	*Rhina ancylostoma*
	Rhynobatidae	*Rhinobatos annandalei*
	Rhyncobatidae	*Rhynchobatus australiae*
	Rhyncobatidae	*Rhinobatos schlegelii*

Mitochondrial COI sequences of 9 species were submitted to National Center for Biotechnology Information (NCBI).

Sampling locations and Genbank Accession numbers of the barcoded species

Sample name	Sampling location (Lat. & Long.)	Accession no.
Mobula japanica	1002'46.60"N, 6602'28.48"E	KJ475198
Mobula tarapacana	9010'38.08"N, 75012'47.84"E	KJ475199
Himantura gerrardi	8036'14.43"N, 74052'06.05"E	KJ475200
Himantura fai	13034'23.63"N, 72031'20.13"E	KJ475201
Galeocerdo cuvier	8043'04.24"N, 72027'20.83"E	KJ475202
Mustelus mosis	10004'47.46"N, 74046'19.50"E	KJ475203
Triaenodon obesus	10004'23.57"N, 65052'46.92"E	KJ475204
Alopias pelagicus	10005'00.67"N, 74045'42.74"E	KJ475205
Sphyrna lewini	8032'57.29"N, 74051'15.85"E	KJ475206

Large pelagic resources

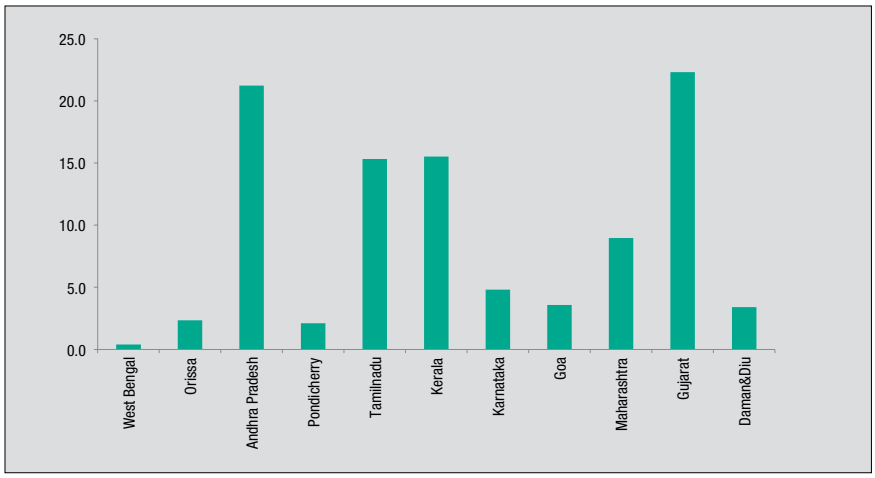
FISHCMFRISIL201200700007

Fishery of large pelagics was monitored from nine centres covering north-west, south-west, south-east and north-east coast and database on catch, effort and catch composition were updated. Large pelagic fishery was supported by tunas, seerfishes, billfishes, barracudas, dolphinfishes, cobia, rainbowrunner, leatherjackets and fullbeaks.

View of large pelagics landed at Cochin Fisheries Harbour

Fishery

Large pelagics contributed 198206 t accounting for 5.5% of the mainland's total marine fish production. Major share of the landing was by tunas (44.8%) followed by seerfishes (24.8%) and barracudas (9.9%). Other major resources were billfishes (4.7%), dolphinfishes (4.5%), carangids (leather jackets and rainbow runners) (7.9%), belonids (1.6%) and cobia (1.6%). Major states contributing to the fishery are Gujarat, Andhra Pradesh, Kerala and Tamil Nadu. Contribution by different states to the landings of each resource varied considerably. Landings recorded a steady increase over the years from



Contribution by different states to catch of large pelagics in 2014

62000 t in 1985 to 198991 t in 2012 and declined marginally thereafter. The change in landings during the year was positive (11.4%) compared to mean yield of the previous five years (2009-2013).

Tuna: Tunas constituted 44.8% of the total large pelagic fishery during the year with a landing of 88841 t. Tuna landings increased steadily over the years with wide annual fluctuations from 23544 t in 1987 to 88841t in 2014. The change during the years was positive (23.8 %) compared to mean yield of the just previous five years (2009-2013).

Fishery was supported by five species of neritic tunas and 4 species of oceanic tunas respectively, representing 68 and 32% of the catch. Kawakawa (*Euthynnus affinis*), frigate tuna (*Auxis thazard*), bullet tuna (*Auxis rochei*), longtail tuna (*Thunnus tonggol*) and bonito (*Sarda orientalis*) represented the netritic group. Oceanic group was represented by yellowfin tuna (*Thunnus albacares*), skipjack tuna (*Katsuwonus pelamis*), big-eye tuna (*Thunnus obesus*) and dogtooth tuna (*Gymnosarda unicolor*).

Landings of different groups of large pelagics by different states

Resource / State	Barracudas	Billfishes	Carangids	Dolphinfish	Full beaks	Kingfish	Seerfishes	Tunas	State total
Andhra Pradesh	2260	2118	1441	944	261	65	7738	27490	42316
Daman & Diu	637	40	649	676	0	321	1200	3217	6740
Goa	107	0	493	7	9	0	445	6000	7062
Gujarat	3818	899	5853	3313	432	1128	15617	11816	42877
Karnataka	2631	72	719	307	179	131	3728	1549	9316
Kerala	1744	5076	329	1467	419	542	3480	17719	30774
Maharashtra	1376	195	1756	822	420	374	7785	5469	18197
Odisha	117	0	2176	105	55	252	1877	124	4705
Pondicherry	1026	85	145	140	0	10	878	1474	3758
Tamil Nadu	5892	750	1990	1112	1770	316	6139	13973	31941
West Bengal	2	0	169	0	0	20	320	10	520
Resource total	19609	9234	15719	8892	3544	3159	49208	88841	198206

Major share of the catch (76.8%) was from the southern coast of India. Contribution from south-east coast was 48.3% , followed by south-west cost (28.4%). North-east coast contributed 23.1%, whereas share of north-east coast was negligible (0.2%). Considerable variation was observed in the spatial pattern in the landings of individual species.

Tunas were landed almost round the year along the mainland coast. In general the major fishing season along the coast was August to October. Along the northwest coast it was September to April, in the southwest coast during August to October, south-east coast during July to September and in the north-east coast from August to September.

Seerfishes: Seerfishes formed 24.8% of the total large pelagic fishery during the year with a production of 49208 t. Fishery was supported by four species- *Scomberomorus commerson* (63.8%), *Scomberomorus guttatus* (35.9%) and small quantities of *Scomberomorus lineolatus* as well as *Acanthocybium solandri.* Seerfishes were exploited all along the coast with major contributions from north-west coast (49.9%), followed by south-east (30.0%), south-west (15.6%) and north-east coasts. Spatial abundance of species varied

Big-eye tuna landed at Cochin Fisheries Harbour

considerably with wider distribution for king seer, *S. commerson* along the entire coast, whereas that of *S. guttatus* was more abundant towards northern sector of east and west coasts. Wahoo, *A. solandri* formed a fishery only along the southern states and the landings stagnated around 49300 t since 2000 with wide fluctuations. Extension of fishing effort to deeper waters added to the increased contribution of large king seer and wahoo. However, production from coastal waters showed marginal decline.

Barracudas: Contributed 9.9% to the large pelagic landings with an estimated landing of 19609 t. Fishery was supported by ten species, dominated by *Sphyraena putnamae* and *Sphyraena jello.* They were landed along the entire coast with major share from south-east coast (46.8%) followed by north-west and south-west coasts. Landings maintained a steady increase till 2012 and thereafter showed a steep downtrend. Landings during the year declined by 27.2% compared to the mean of previous five years.

Billfishes: Billfishes contributed 9234 t, accounting for 4.7% of the large pelagic landings. Fishery was supported by five species; three species of marlins and one species each of sailfish and swordfishes. Marlins (Family: Istiophoridae) were represented by two genera; *Makaira* and *Tetrapturus*. *Makaira indica*, *Makaira mazara*, and one species under the genus *Tetrapturus* were common in the catch. Sailfish in the catch was represented by *Istiophorus platypterus* and swordfish (Family Xiphidae) by *Xiphias gladius*. Catch was dominated by sailfishes (46.5%), followed by marlins and swordfishes which were landed all along the coast, except northeast coast with major share from southwest (55.8%) and southeast coasts (32.0%). Landing exhibited steady increase till 2010 and thereafter exhibited stagnation. During the current year, showed marginal uptrend compared to the mean landings of previous five years.

Dolphinfishes: Contributed 8892 t accounting for 4.5% of the large pelagic landings. Fishery was supported by two species; *Coryphaena hippurus* and small quantities of *Coryphaena equiselis.* They are landed all along the coast, but major contribution (54.2%) was from north-west coast. Though they formed a fishery during the past several years, an increasing trend in their landings was noticed during the recent past due to increased contribution from deeper waters.

Cobia: Formed 1.6% of the total large pelagic fishery during the year with a production of 3,159 t. Fishery was supported by single species, *Rachycentron canadum.* Landing showed a steady increase over the period. Cobia was landed along the entire coast with major share (57.7%) from northwest coast. Appreciable quantity was landed along the southwest (21.3%) and southeast (12.4%) coasts also.

Carangids: Large carangids were represented by rainbow runner (*Elagatis bipinnulata*) and queenfishes (*Scomberoides tol, S. tala, S. commersonianus* and *S. lysan*) and formed 7.9% of the total large pelagic landing with a production of 15719 t. Fishery was supported by a lone species of rainbow runner and four leather jackets. Excluding the heavy landings in 2008, their

yield showed a gradual and steady increase over the period. They are landed along the entire coast with major share (52.5%) from north-west coast.

Needlefishes: Contributed 1.8% to the total large pelagic landings with a production of 3544 t. Fishery was supported by four species (*Strongylura strongylura, Strongylura leiura, Tylosurus crocodilus* and *Ablennes hians*). Fishery highly fluctuated over the years and showed decline in yield during the last decade. Landings during the year registered a decline of 26.9% compared to the mean yield of the previous five years. Though the group formed a fishery along the entire coast, northwest was most productive for the species, with a contribution of 49.9%.

Mode of exploitation

Fisheries for large pelagics involved different craft and gear combinations. Most fishing units carry variety of gears, however operation of which depends on the resource targeted and ground conditions. Large pelagics form target species in some and bycatch in other gears. Almost 50% of the catch was by gillnets followed by trawls, purseseines and ringseines. Drift gillnets generally targeted fishes which occupy the upper layers of water column and hooks and lines targeted those from deeper layers.

Contribution of different gears to major large pelagic resources

Gear	Trawl	GN	HL	PS	RS	MDOL	NM
Barracudas	68.1	22.5	2.6	4.9	0.8	0.1	0.9
Billfishes	2.7	66.5	29.9	0.5	0.0	0.0	0.4
Carangids	26.9	48.4	13.6	8.7	1.1	1.2	0.2
Dolphinfish	22.3	53.6	18.7	4.3	0.6	0.1	0.4
Fullbeaks	12.8	59.9	11.7	10.1	3.3	0.0	2.2
Kingfish	23.0	53.8	20.7	1.9	0.0	0.6	0.0
Seerfishes	27.0	54.8	8.5	4.8	1.9	2.0	0.9
Tunas	2.8	50.2	18.4	12.0	16.2	0.1	0.3
Total	18.6	49.9	14.2	8.2	8.0	0.7	0.6

Taxonomy

Based on the taxonomic details collected and the available published information a key was developed for field identification of species.

Biology

Biological observations of the major species of large pelagics landed indicated that major share of the catch landed were adult population. However in the case of some groups like seerfishes and swordfishes, large numbers of small sized fishes were landed occasionally at Cochin Fisheries Harbour by different gears. Small ones predominated (in numbers) the catch on occasions when fishing was done over and around seamounts and oceanic ridges.

Food and feeding studies showed that all species are highly predatory and carnivorous in feeding habit. Major prey items were pelagic finfishes, crabs and oceanic squids/octopus. Food of fishes caught from oceanic waters

were constituted by *Decapterus* sp., small sized tunas (*A. rochei, A. thazard, K. pelamis*), flyingfishes, halfbeaks, big-eye scad, myctophids, pelagic crabs (*Portunus* spp., *Charybdis* spp.), squids, octopus and myctophids. Food of fishes caught from continental shelves consisted mainly of sardines, anchovies, scads, horsemackerel, *Saurida* sp., *Chorinemus* spp., mackerel, *E. diacanthus,* whitebaits, shrimps and crabs.

Population parameters of the major species

Species	L_r (cm)	L_{ma} (cm)	Mean (cm)	L_c (cm)	L_{mat} (cm)	SSB%
T. albacares	30	183	106.4		57.6	59.2
K. pelamis	28	98	53.7		40.9	38.7
G. unicolor	36	148	76.4		69	42.7
T. tonggol	24	88	56.3		49.8	65.4
E. affinis	32	78	47.3		37.7	53.6
A. thazard	22	54	35.7		29.7	48.7
A. rochei	18	42	27.1		23.6	34.7
S. orientalis	24	60	39.2		42	46.3
S. commerson	33	158	77.8			31.4
S. guttatus	33	105				
A. solandri	73	138	92.1			62.3
M. indica	120	280	198			
I. platypterus	90	235	164.6			
X. gladius	58	190	97.6			
S. putnamae	35	97	54.6		47.6	
S. barracuda	59	132	89.7		89.3	
S. jello	36	28	83.7		67.4	
S. obtusata	21	28	23.9		23.4	
E. bipinnulata	34	108	54.6	52.3	64.6	
S. commersonianus	28	119	67.4	-		
C. hippurus	32	151	78.8		43.7	56.4
C. equiselis	24	55				
R. canadum	40	170	81	72.3	68	

Stock status

Conventional and rapid stock assessment of large pelagics as a group and individual resources/species separately shows that the resource as a whole is in abundant state and yield is on steady increase. Among the component resources, except needlefishes stock of all resources is in abundant state, whereas in the case of the latter it was in less abundant state. The situation suggests considerable scope for further enhancing the production of all species, except needlefishes. The present fishing pattern indicated that coastal based fishery is restricted to limited areas of the coast. Fishery is concentrated mainly along the south and north-west coasts and targets mainly surface resources. This suggests scope for increasing the production by extending fishing to less exploited areas and to deeper layers. Effort by long-lines should be increased to exploit resources of less targeted areas; both horizontally and vertically in oceanic waters of Indian EEZ. Native fishers need to be encouraged to take up oceanic fishing by providing adequate support in the form of infrastructure and incentives.

Bivalve fisheries and management

Research Project: FISHCMFRISIL201201200012

CMFRI research leads to India's first MSC certified fisheries

CMFRI's initiatives in studying and managing the short-neck clam (*Paphia malabarica*) fisheries of Ashtamudi Lake since the 1990s helped the WWF, India in identifying this small-scale fisheries as an ideal candidate for Marine Stewardship Council (MSC) certification. After three years of relentless hard work, the WWF and CMFRI have together achieved a landmark in Indian fisheries by obtaining MSC certification for the short-necked clam fishery of Ashtamudi Lake, Kerala in November, 2014. The MSC's fishery eco-labelling and certification programme allows consumers to identify and support environmentally responsible fishing practices through purchasing decisions. Consumer support for sustainable fishing in the market place leads to economic benefits for well-managed fisheries and long-term sustainability of fisheries, ensuring secure livelihoods and continuous availability of fish for food. When a fishery is successfully certified against the MSC Standard, products from the fishery can be sold with the MSC's unique ecolabel, which identifies seafood as coming from a well-managed fishery.

The short-neck clam fishery in the Ashtamudi Lake in Kerala has received India's first Marine Stewardship Council (MSC) certification which will help boost sustainable fisheries and also protect the ecosystem. It is the first MSC certification in India; and third in Asia (after Vietnam and the Maldives). MSC's scoring system puts the fishery in the best practice category on 29 of the 31 indicators, with scoring greater than 80 out of 100. The MSC certification

The short-neck clam fishery in Ashtamudi Lake, Kerala

Summary of MSC Principle level scores for the Ashtamudi Estuary Short Necked Clam Fishery

MSC FISHERIES STANDARDS

Principle 1: Sustainable Fish Stocks

The Fishing activity must be at a level which ensures it can continue indefinitely

Principle 2: Minimising environmental impact

Fishing operations must be managed to maintain the structure, productivity, function and diversity of the ecosystem

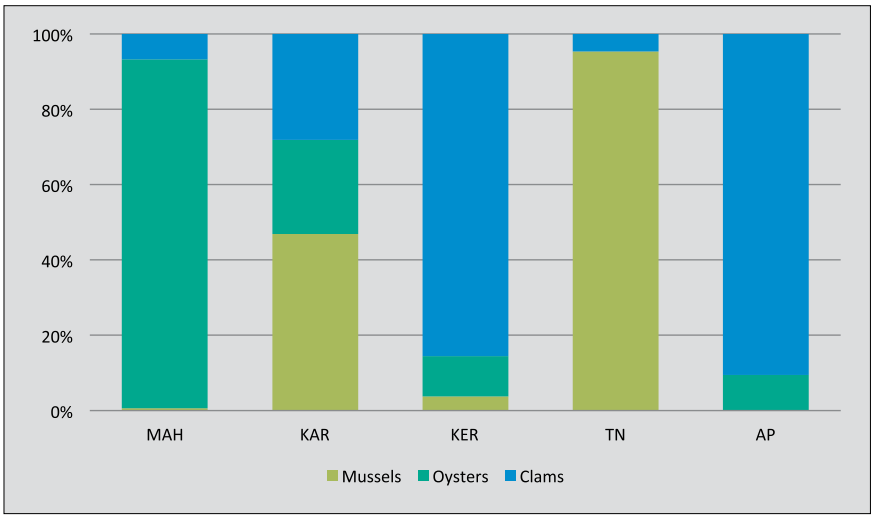
Principle 3: Effective management

The fishery must comply with relevant laws and have a management system that is responsive to changing circumstances

was a joint effort by CMFRI, WWF, Kerala State Fisheries Department and the local fishing community. The certification demonstrates the power of collaboration between partners and the importance of a new council-based management system for clam fishery governance. Benefits of certification include potential for premium prices, access to new markets, preferred supplier status, potential to attract ethical investment in the fishery or funding for local community social and economic infrastructure, improvements in management of fisheries and public recognition of fishery conservation efforts.

National bivalve production

Bivalve production in estuaries and important landing centres along the States of Kerala (KER), Karnataka (KAR), Maharashtra (MAH), Tamil Nadu (TN) and Andhra Pradesh (AP) were estimated by species. The annual landing of clams, oysters and mussels from Ratnagiri, Karwar, Mangalore, Calicut, Kochi, Vizhinjam, Tuticorin, Chennai and Kakinada was estimated at 134235 t. The estimated bivalve production registered an increase by 18% when compared to the catch in previous year (113858 t). Clams formed 81.1% of the annual bivalve production, oysters 11.2% and mussels 7.8%.



Contribution of bivalve groups to the total landings by State

Estimated bivalve landings (t) in India-2014

Species	Maharashtra	Karnataka	Kerala	Tamil Nadu	Andhra Pradesh	Total (t)
Clams						
Paphia malabarica (PM)	0.9	1379	30948	19	61	32409
Meretrix meretrix (MM)	1.8	107		15	176	299
Meretrix casta (MC)	0.5	316	7543	30	1	7891
Marcia opima (MO)	1.1	25		64	117	207
Villorita cyprinoides (VC)		55	67510			67565
Anadara sp.					401	401
Gafrarium diverticulum	0.4					0.4
Others	0.9				34	34.9
Total	5.7	1,882	1,06,002	128	791	1,08,808
Oysters						
Crassostrea madrasensis	0.6	1573	13177		60	14810
Saccostrea cucullata	75	97				172
Others	2.4		10		23	35.4
Total	78	1,670	13,187		83	15,015
Mussels						
Perna viridis	0.5	3129	3826	130		7085
Perna indica			824	2500		3324
Total	0.5	3,129	4,649	2,630		10,409
2014	84	6,681	1,23,838	2,758	874	1,34,235
2013	24.3	7361	1,05,754	123	595	1,13,858

Kerala: Major share of the bivalve production of the country was reported from the State of Kerala (92.3%). Clams formed 85.6% of bivalve production in the State followed by edible oysters (10.6%) and mussels (3.8%). Bivalve production along the Malabar Coast was estimated at 71189 t contributing 57.5% to the State production. *Villorita cyprinoides, P. malabarica* and *M. casta* contributed to the fishery forming 52% of the total clam production from Kerala. Green mussel, *Perna viridis* catch, estimated at 3441 t in the region, contributed to 74% of the mussel production from the State.

Estuarine waters of central Kerala contributed 48% to the clam production of the State. Production of *P. malabarica* in Ashtamudi Lake during March to November 2014, estimated at 10811 t recorded 1% decrease compared to 2013 (10,907t). Self-imposed ban on fishing during December 2013 to February 2014 for *P. malabarica* continued in the region. Black clam (*Villorita cyprinoides)* production in Vembanad during 2014 estimated at 39,851 t, showed an increase by 32% (9672 t) in comparison with 2013. Maximum catch was recorded from Muhamma and Vechoor clam shell society (72% of the catch) and the rest was contributed by Komalapuram, Vaikom, Thaikattusery and Kuthiathode clam society. The production of black clams declined from a peak of 56,700 t in 2007 to 39,851t in 2014. In Chettuva Estuary, the clam

fishery was supported by *M. casta*. Total bivalve production estimated at 460 t registered a decrease by 44%.

Species	Area	Length range (mm)	Spawning season	Lmean (mm)	Lopt (mm)
V. cyprinoides	Vembanad	19-49	Jul-Sep	26.8	29.8
P. malabarica	Ashtamudi Lake	11.7-44.9	Oct -Jan, Mar -May	26.9	25

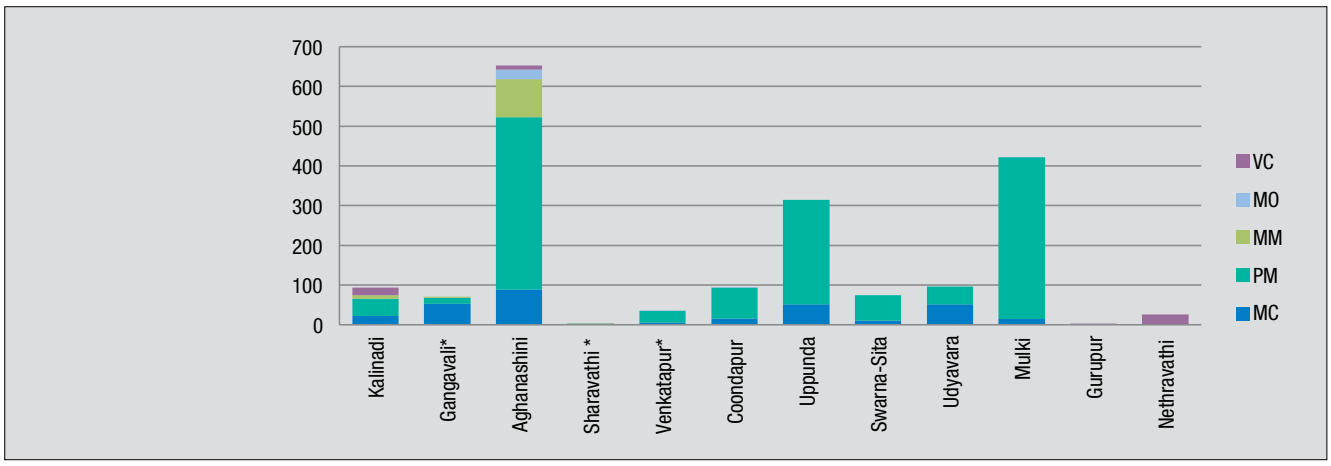
Estimated landings of mussels and oysters from Kollam, Alappuzha, Ernakulam, Trichur and other districts of Central Kerala were 319 t and 384 t respectively. Brown mussel fishery was observed only along the Vizhinjam coast to the tune of 824 t, showing 24% increase from the previous year. Size range in the fishery ranged from 50-99 mm.

Species	Area	Length range (mm)	Spawning season	L_{mean} (mm)	L_{opt} (mm)
P. indica	Vizhinjam coast	50-100	June-July	80	74

Karnataka: Clam production in Karnataka during 2014 was estimated at 1,882 t from Kalinadi, Gangavalli Aghanashini, Sharavathi, Venkatapur, Coondapur, Uppunda, Swarna-Sita, Udyavara,Mulki, Gurupur and Nethravathi. Clam production recorded a decreasing trend by 63% due to poor spat settlement during the post-monsoon months of 2013. *Meretrix casta* and *P. malabarica* contributed 90% to the total clam production. Clams were transported in bulk quantities by road and by rail from estuaries of Kerala and transplanted in Coondapur Estuary prior to retailing in local markets of Karnataka and Goa. Biomass surveys were conducted in Nethravathi, Gurupur, Mulki, Sita and Swarna estuaries of Dakshina Kannada and Udupi District of Karnataka. Natural mortality in all clam species were observed during March to May in shallow clam beds of Aghanashini, Coondapur, Swarna-Sita, Udyavara, Mulki, Gurupur and Nethravathi estuaries.

Edible oysters formed a good fishery along the Karnataka coast. Production from estuaries was estimated at 1,670 t. *Crassostrea madrasensis* contributed 94% of the production.

Green mussel *Perna viridis* production (3,129 t) registered 44% increase in



Clam landings in estuaries of Karnataka by species

Bivalve marketing at Bhatkal, Karnataka

the State compared to 2013. In Uttara Kannada District, mussel fishery was observed along Belekeri, Ankola Keni, Belambar, Belekeri, Tadri, Manki and Murudeshwar. Fishermen from Ankola picked mussels near Belambar and Tadri. Mussel fishers from Kerala were not permitted to harvest mussel along the entire stretch of Uttara Kannada District. Mussel fishery along Udupi and Dakshina Kannada Districts were observed along Byndoor, Nagoor, Kirimanjeshwara, Gangoli, Malpe, Surathkal and Someshwara. Fishermen from Kerala were permitted to collect mussels from the sub-tidal beds off Surathkal and Malpe.

Saccostrea cucullata collected at Mirya, Maharashtra

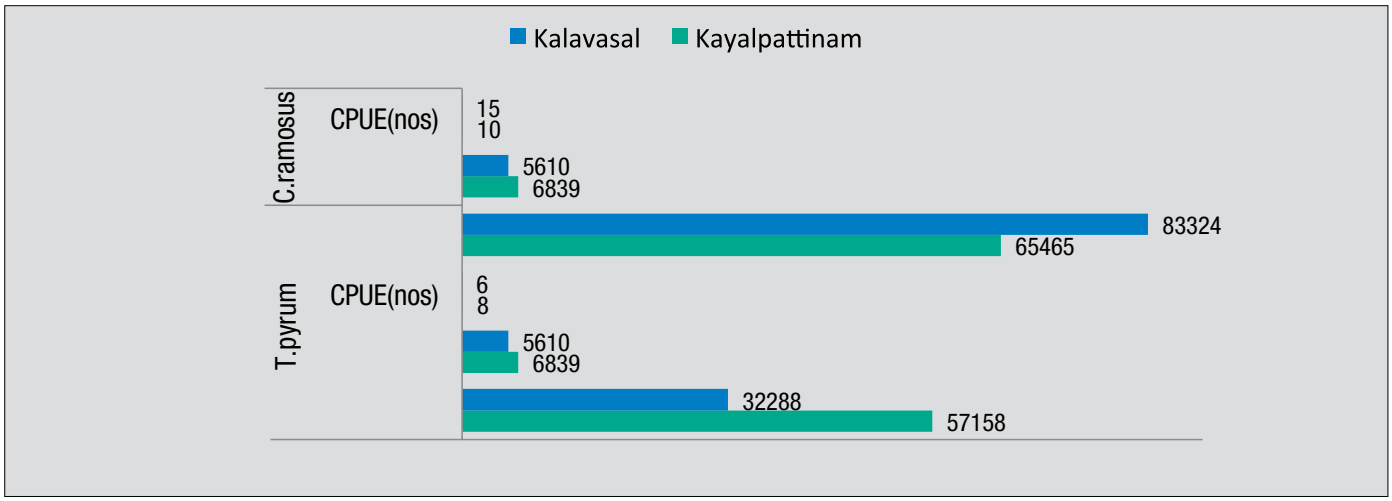
Maharashtra: A survey was conducted along Mirya Creek Ratnagiri, Maharashtra during December 2013 to ascertain the bivalve resources and it was observed that Indian rock oyster, *Saccostrea cucullata* locally known as '*Kalva'* is exploited from the creek. About 25 fisherwomen are engaged in collecting oysters from Mirya Creek during low tide. The catch per effort varies from 35 to 50 kg shell-on oysters in man-days. It was estimated that from Mirya area approximately 75 t of shell-on oysters are collected annually. The oysters are transported to the important domestic markets in Maharashtra and sold shell-on and as wet-shucked oyster meat.

Ornamental gastropods

Research Project: **FISHCMFRISIL201201300013**

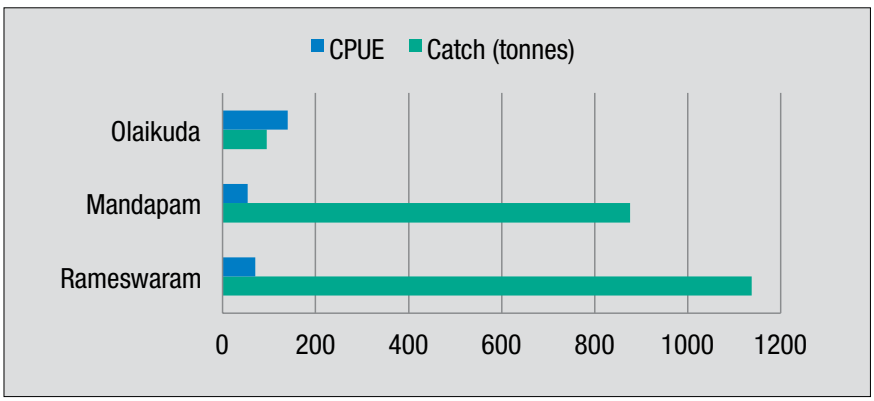
During 2014, additional landing centres were covered to have wider landing estimates of ornamental gastropods. Two centres at Tuticorin, one each at Mandapam, Rameswaram, Olaikuda and Kakinada were monitored for the gastropod fishery. Biology of selected species were also studied from Kollam in Kerala. Information on shell craft industries in various identified centres were collected and documented.

Tamil Nadu: Gastropod fishery from two landing centres at Tuticorin (Kayalpatnam and Kalavasal), by bottom-set gillnets for the sacred chank *Turbinella pyrum* and *Chicoreus ramosus,* which formed regular fishery were monitored.



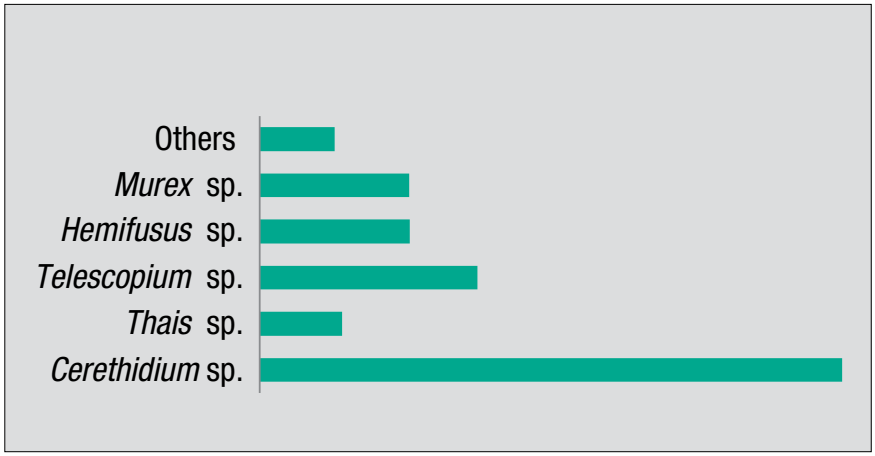
Annual estimated landings and CPUE of *T. pyrum* & *C. ramosus* at Kayalpattinam & Kalavasal during 2014

At Mandapam and Rameswaram, gastropods landed by trawlers as bycatch was monitored from September 2014. Twenty three species from Mandapam and 17 species from Rameswaram supporting the fishery were collected and documeted. At Olaikuda, vallam and katamaran are used specifically for exploiting gastropods primarily to cater the shell craft industry.



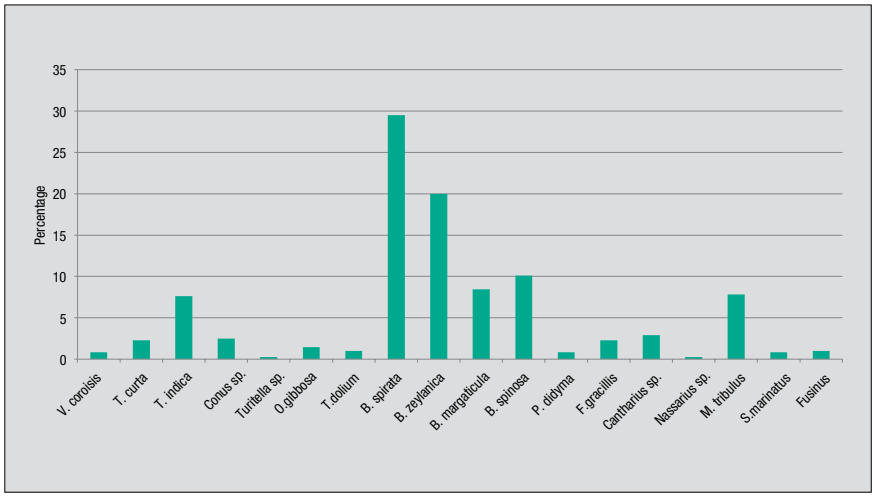
Gastropod landings at different landing centres in Tamil Nadu

Andhra Pradesh: At Kakinada Bay bimonthly catch details of gastropods were collected and documented.



Annunal catch (t) of different species of gastropods at Kakinada Bay during 2014

Kerala: During 2014, an estimated 584 t of gastropods were landed by trawlers in Kollam District. Compared to previous year, the present catch showed increase by 64%. Catch from two major landing centres namely Neendakara Fishing Harbour (NDK) and Sakthikulankara Fishing Harbour (SAK) alone formed 97% of the catch landed in Kollam District. Landing was mainly by two gears *i.e.,* MDTN and MTN, with MTN contributing more to the fishery. Annual average catch per unit effort at NDK and at SAK were 2 kg (MDTN) – 11.3 Kg (MTN) and 14 kg (MDTN) - 117. 7 kg (MTN). Maximum catch and catch rate was observed during May at SAK and April, September and November at NDK. During this period, the main species exploited was *Babylonia spirata* followed by *Babylonia zeylanica, Bursa spinosa* and *Bursa margariticula, Conus* sp., *C. virgenius, Natica* sp., *Tibia curta, Oliva* sp., *Nassarius* sp., *Ficus* sp. and *Turricula* sp. *Phalium glaucum* and *Cantharius* sp. formed a minor proportion.



Species composition of gastropods (%) at Kollam

Shell craft industry

Shell craft industry can be categorised into two based on the market of the products : those which sell products to indigenous/local markets within the country and the other which exports items to niche markets abroad. Selected ornamental gastropod shells are also imported from various countries, processed here and re-exported to other countries.

Processing of cuttlebones

Details on import of ornamental gastopod shells

Species	Source countries
Busycon sp.	Florida, USA
Haliotis sp.	Mexico, New Zealand and South Africa
Cypraea tigris	Australia, Philippines
Mitrella sp.	Spain and African countries

Export of ornamental gastropod shells

Place of export from India	Importing countries
Rameswaram	Australia, South Africa and Germany
Tuticorin	Columbo, USA, France, Neatherlands, Germany, Australia, Los Angeles
Chennai	Belgium, Croatia, Norfolk (England), New York , Haiti Island

The industry imported nearly 20 to 25 species from other countries *viz*., *Nodipectin nodosus*, *Nodipectin subnodosus*, *Cymbiola nobilis*, *Haliotis fulgens*, *Haliotis rufescens*, *Haliotis corrugata*, *Chlamys* sp. (*Bractechlamys vexillum*, *Chlamys senatoria*), *Melongena melongena*, *Melongena corona*, coloured cockle shells, *Muricanthus nigritus*, *Pecten nobilis*, *Pecten analis*, *Strombus vittatus*, *Ovula ovula* and *Busycon* sp. In addition to the shell crafts, cuttlebones are also exported from Tuticorin in large scale. The cuttlebones are processed, packed and exported as calcium supplement for pet birds.

Gastropod operculum trade at Tuticorin

Regular export of gastropod operculum is being done from Tuticorin, especially from Kalavasal landing centre. Gastropod operculam from three species mainly *Lambis lambis, Chicoreus ramosus* and *Turbinella pyrum* commands good market value. The unprocessed gastropod operculam is first sent to Rameswaram and then from there to Dubai markets.

Details on export of opercula of three major species of gastropods from Kalavasal

Year	*Turbinella pyrum*			*Chicoreus ramosus*			*Lambis lambis*		
	Nos.	Weight (kg)	Value (₹)	Nos.	Weight (kg)	Value (₹)	Nos.	Weight (kg)	Value (₹)
2011	60,880	15.22	33000	0	0	0	23700	4.64	64960
2012	54,728	13.62	29700	68600	343	1269100	18740	4	51380
2013	36,228	9.06	19800	46852	234	866540	20265	4	55580
2014	32,288	8.07	17600	70526	353	1304620	22995	5	63000

Chicoreus ramosus ₹3,700 per kg

Lambis lambis ₹14,000 per kg

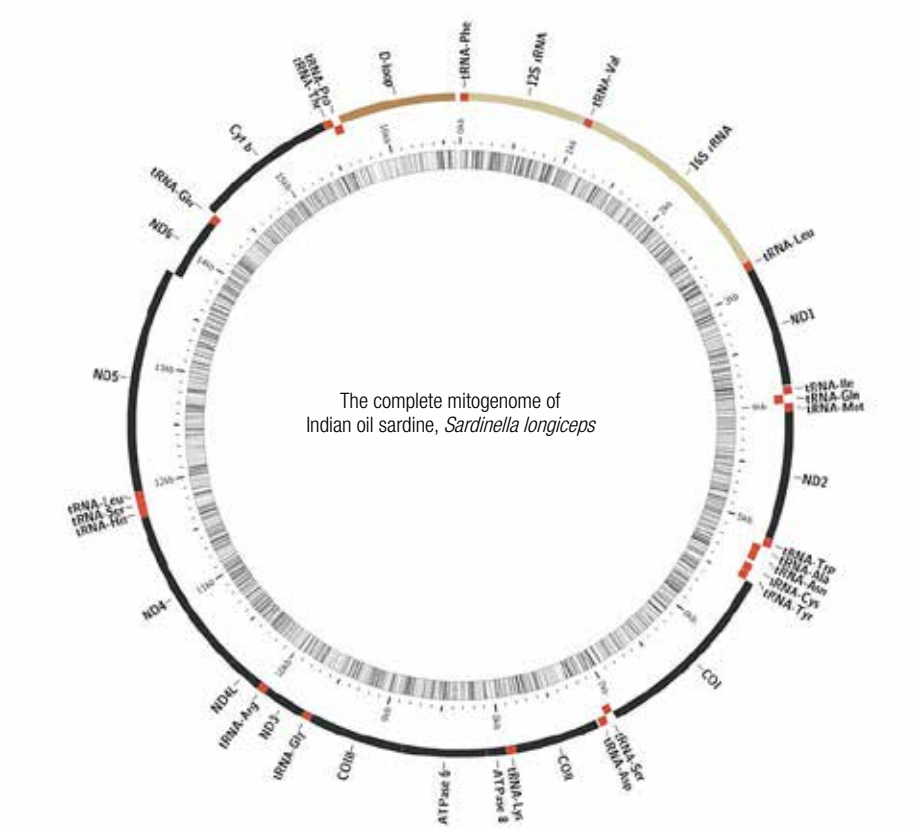
Turbinella pyram ₹2,700 per kg

FISH GENETICS AND GENOMICS

Characterization of the complete mitogenome of Indian oil sardine, *Sardinella longiceps*

Research project: FISHCMFRISIL201202800028

The complete nucleotide sequence of the mitochondrial genome of Indian oil sardine, *Sardinella longiceps* (Teleostei: Clupeiformes) was characterized. The entire genome was purified by gene amplification using polymerase chain reactions (PCR), as overlapping segments and the products were subsequently used for direct sequencing. The assembled mitogenome is a 16,613 bp circle, containing 37 mitochondrial structural genes (two ribosomal RNA, 22 transfer RNA, and 13 protein-coding genes) and the gene order is identical to that in typical vertebrates.



The complete mitogenome of Indian oil sardine, *Sardinella longiceps*

Characterization and comparison of mitochondrial control region of Indian oil sardine, *Sardinella longiceps* from different locations

Control region is the major non-coding region of the mitochondrial genome evolving 3-5 times faster than the rest of the mitogenome and the characteristics of this region was analysed in detail in *Sardinella longiceps* collected from all over the Indian coast (274 samples collected from Veraval, Mumbai, Mangalore, Calicut, Kochi, Kollam, Trivandrum, Chennai and Vizag). This region is located between the $tRNA^{Pro}$ and $tRNA^{Phe}$ genes with their important function being regulation of replication and transcription of the mitochondrial genome. *Sardinella longiceps* control region showed extensive length variability which was associated with the occurrence of variable number of tandem repeats starting from position 802. There were four length variants mainly of; 943, 984, 1014 and 1023 base pairs based on the variation in the frequency of occurrence of 3 perfect or imperfect repeats (38bp for perfect repeats). The control region of Indian oil sardine consisted of CSB D (16bp), CSB2 (17bp), CSB3 (15bp), Poly T(8bp), a conserved domain and tandem repeats. The content of A/T bases were more than C/G bases among the analyzed sequences (mean: A=30.3%, C=16.5%, G=21.8% and T=31.4%). The polymorphisms in control region size are related to strand slippage and mis-pairing during replication. The repeat units also have a major role in the formation of stable secondary structures during replication and these secondary structures become increasingly energetically stable with increasing number of perfect repeat copies.

Population genetic analysis of Indian oil sardine, *Sardinella longiceps* using mitochondrial DNA markers

We assessed the genetic diversity of Indian oil sardine using mitochondrial control region sequences. A 1096 bp portion of the control region was amplified in 274 individuals collected from the distribution range of Indian oil sardine (Veraval, Mumbai, Mangalore, Calicut, Kochi, Kollam, Trivandrum, Chennai and Vizag). There were a total of 229 haplotypes with a very high haplotype diversity value of 0.99. The most abundant haplotype was found in 4 individuals. There were 239 variable sites with 80 transitions, 30 transversions and 149 singleton sites. The number of parsimony informative sites was 90 with average number of nucleotide differences being 9.65. The average number of nucleotide differences was highest between Mangalore and Vizag (18.9) and Mangalore and Kochi (18.4). The average nucleotide diversity value for all sequences was 0.013. The haplotype diversity values were higher and nucleotide diversity values were lower and this pattern is characteristic of populations having undergone a demographic expansion. A spatial expansion might also have taken place during this period.

Population genetic analysis of Indian oil sardine, *Sardinella longiceps* using microsatellite markers

The genetic stock structure of Indian oil sardine is studied using microsatellite markers. 11 microsatellite markers were developed using the method of cross amplification in *S. longiceps* to infer population genetic structure. The samples were collected from Veraval, Mumbai, Mangalore, Calicut,

Trivandrum, Chennai and Vizag. Microsatellite genotyping is carried out on the ABI Prism genetic analyzer with primers labeled using 6FAM fluorescein dye. Alleles are identified using allele calls in GENEMAPPER software. Alleles are being mapped for 96 samples from each location.

Studies on morphological variants of Indian oil sardine, *Sardinella longiceps*

Morphotypes in Indian oil sardines were studied using morphometric ratios, Cytochrome C Oxidase genes, control region sequences, rhodopsin gene sequences and proximate composition analyses. Morphological variants (stout and slender forms) of Indian oil sardines were collected from Calicut (30 each) and 21 morphometric characters and 8 meristic characters were measured in all the samples. All the morphometric characters were then converted to percentage of standard length (SL). Six morphometric characters; distance from snout to pectoral, caudal width, depth at dorsal, depth at anal, dorsal height and dorsal base length were significantly different between the two variants. Cytochrome C oxidase gene sequences, control region sequences and rhodopsin gene sequences did not show any significant divergence between the two variants. A proximate composition analysis (dry matter basis) showed significantly high protein content in slender sardine and significantly high fat content in stout sardine.

Genetic stock structure study on breeding stock of Indian Mackerel, *Rastrelliger kanagurta*

Research Project: EF-18/BOBLME

Fresh samples of Indian mackerel *Rastrelliger kanagurta* belonging to the breeding stock were collected from 7 sampling sites (Mumbai, Calicut, Tuticorin, Nagapatnam, Kakinada, Paradeep and PortBlair) along the Indian coast for microsatellite analysis. 14 microsatellite primers were identified for genotyping the samples collected from each location. Microsatellite genotyping has been carried out on the ABI Prism genetic analyzer with primers labeled using 6FAM fluorescein dye and alleles were identified using allele calls in GENEMAPPER software. We have completed genotyping of 30 samples of Indian mackerel, *Rastrelliger kanagurta* from 7 locations using the 14 labelled primers. Results of a preliminary analysis showed that highest allelic richness, observed heterozygosity and gene diversity was in samples collected from Paradeep. Maximum numbers of alleles were given by primer Raka 12. Final data sharing and analysis workshop was conducted at Phuket, Thailand during 17-18 Feb 2015. During the final workshop CMFRI agreed to analyse 60 DNA samples from Thailand (30 samples from Ranong and 30 samples from Satul) using 4 primers; KSJ26, KSJ 18, RAKA 26 and RAKA 48. We have completed genotyping of all the samples from Thailand using those 4 primers.

Population genetics of *Lutjanus argentimaculatus* and *Eleutheronema tetradactylum*

Research Project: EF-28/ICAR Outreach Activity 1 Fish Genetic Stocks

Genetic stock structure investigations on two species of mariculture importance, *Lutjanus argentimaculatus* and *Eleutheronema tetradactylum*

have been initiated using microsatellite and mitochondrial DNA markers. Fresh samples of both the species have been collected from 3 locations out of the 10 locations selected for sampling based on the range of distribution. Microsatellite primers have been synthesized for both the species in order to carry out cross species amplification trials. Primers amplified in *Lutjanus russelli, L. campechanus* and *L. analis* were selected for cross species amplification in *L. argentimaculatus* and primers from *Polydactylus sexfilis* were selected for *E. tetradactylum*. In addition to genetic study, stock structure analysis is also being carried out using truss network analysis.

Functional genes related to traits having commercial importance from Fin fishes

Functional genes related to growth are important targets in both capture and culture fisheries. Polymorphic forms of such genes are useful in distinguishing genetic stocks with better characteristics which could be propagated in culture as well. Myostatin (MSTN) is a member of the transforming growth factor- Beta-super family that negatively regulates growth of muscle tissue. There are two isofroms namely MSTN-1 and 2. As a pioneering attempt, two exons of MSTN-1 intervened by an intron was amplified (1150 bp) by PCR from the red Snapper *Lutjanus argentimaculatus* using the genomic DNA as template with primers designed from the conserved regions in perciformes. Further attempts to completely amplify the whole gene is going on which would serve as baseline information for further studies in the population genomics of finfishes of commercial importance.

Functional genomics of the abiotic stress response in extremophilic and extremotolerant microalgae

Research Project : FISHCMFRISIL201202800028

Global warming is real and imminent and would result in increased ocean pH and increased soil salinity in coastal areas. These environmental changes will adversely affect agricultural production. Development of crops with ability to withstand these adverse environments along with optimal production is essential. Transgenic approach is a faster and sure method than selective breeding in development of crop varieties with such properties.

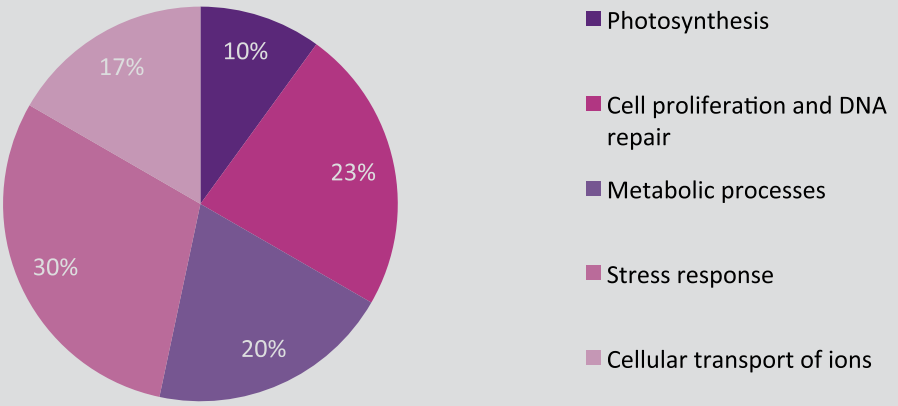
Three different microalgae capable of withstanding decreased pH, increased salinity and increased temperature were identified and characterized. An acid tolerant euryhaline microalga, *Dictyosphaerium ehrenbergianum* was isolated and characterised from Pulicat Lake. Hyperhaline microalgae, *Tetraselmis indica* was isolated and characterised from salt pans of Tuticorin. A temperature and salinity tolerant microalgae *Scenedesmus sp* was isolated and characterised from hot springs of Manikaran, Himachal Pradesh. Genes that are differentially expressed in these microalgae when they are subjected to the respective abiotic stresses were identified using Suppression Substractive Hybridisation (SSH) Assay.

The SSH library was prepared, sequenced and analyzed; the reliability of data was verified and confirmed using Real Time Quantitative PCR. A large number of novel unidentified genes were obtained. All the identified genes are directly or indirectly involved in the respective abiotic (pH, temperature and salinity) stress tolerance mechanisms and most of them are actively

involved in biological process of the cell. Selected genes from these three SSH libraries were assessed for its suitability as a transgene for imparting stress tolerance using prokaryotic expression system, i.e., through acquired stress tolerance in *E. coli* through recombinant expression.

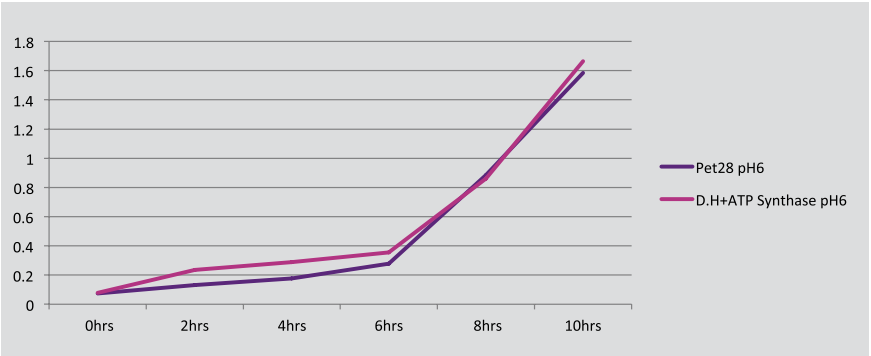
Acquired Acid Tolerance in *E. Coli* through recombinant expression of H+ ATP synthase gene from *Dictyosphaerium ehrenbergianum*

From microalga *Dictyosphaerium ehrenbergianum* genes differentially expressed under acidic stress was obtained by SSH, total of 200 randomly selected transcripts were sequenced and characterised, the reliability of data was verified and confirmed using Real Time Quantitative PCR. All the identified genes are directly or indirectly involved in the acid or abiotic stress tolerance mechanisms and are actively involved in biological process of the cell. Among the gene fragments analysed 55% showed sequence similarity with functional genes, 21% unknown genes which may have functional roles



Functional classification of differentially expressed genes under acidic stress

in abiotic stress and the remaining 24% contributed ribosomal genes. Among the identified functional genes 30% were those having role in stress response, 23% involved with cell proliferation and DNA repair, 20% associated with metabolic processes, 17% involved in cellular transport of ions and 10% associated with photosynthesis.



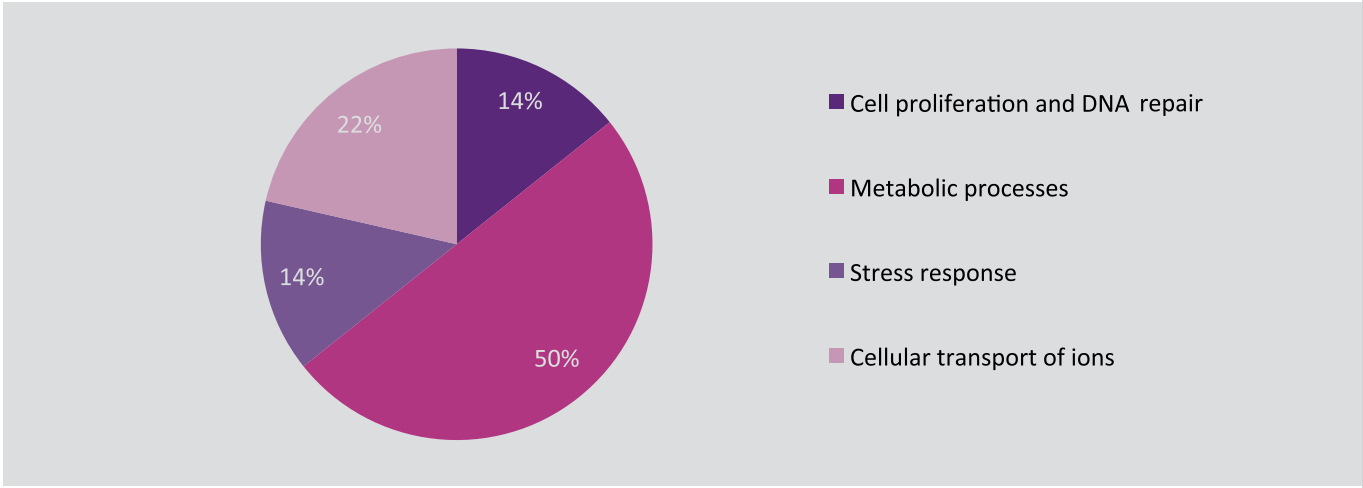
The growth pattern of *E. coli* cells transformed with pET28H+ATP synthase and empty pET28b under acidic stress

From the SSH library H+ ATP synthase gene which is involved in intracellular pH homeostasis and having role in various abiotic stresses was recombinantly expressed in *E.coli* cell. The recombinant cells acquired acidic tolerance when compared to untransformed cells. *Dictyosphaerium* H+ ATP synthase was functionally validated and found to impart pH tolerance in a heterologous species.

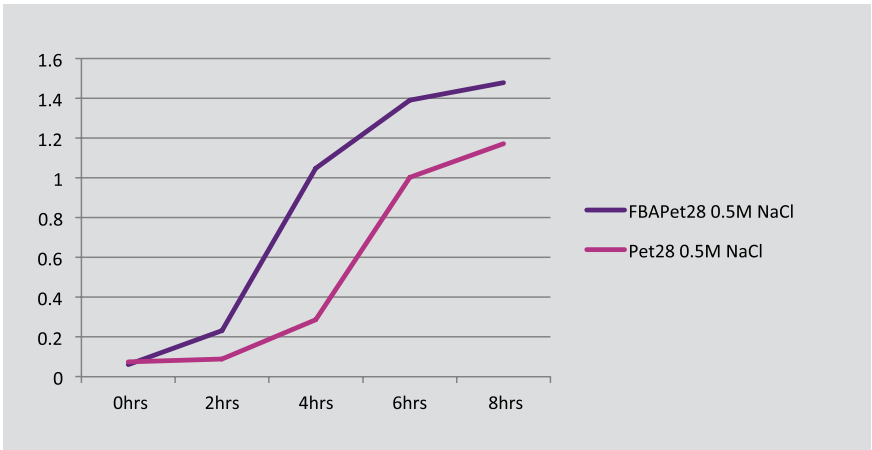
Acquired Salinity Tolerance in *E. Coli* through recombinant expression of Fructose-1,6-bisphosphate aldolases (FBA) from microalgae *Tetraselmis indicus*.

From microalgae *Tetraselmis indicus* genes differentially expressed under acidic stress was obtained by SSH. 200 numbers of clones were randomly selected and sequenced and analysed. 50% of the genes were involved in metabolic processes, 22% in cellular transport of ions 14% involved in cell proliferation and DNA repair and the rest 14% involved in stress response. The upregulation of selected identified genes were verified using Quantitative real time PCR.

The gene fructose-1,6-bisphosphate aldolases (FBA) which is actively involved in plant photosynthesis and growth, and has great significance during hyperosmotic stress was identified from the SSH library for functional



Functional classification of differentially expressed genes under osmotic stress

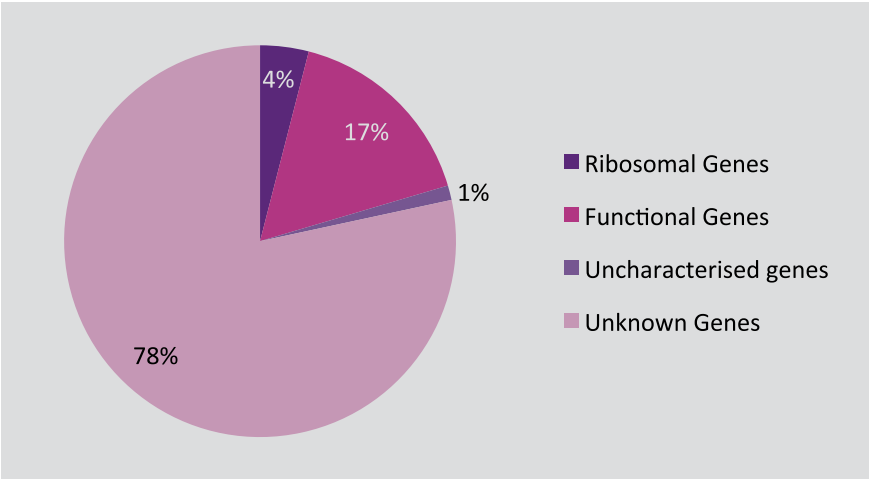


The growth pattern of *E. coli* cells transformed with pET28 FBA and empty pET28b under acidic stress

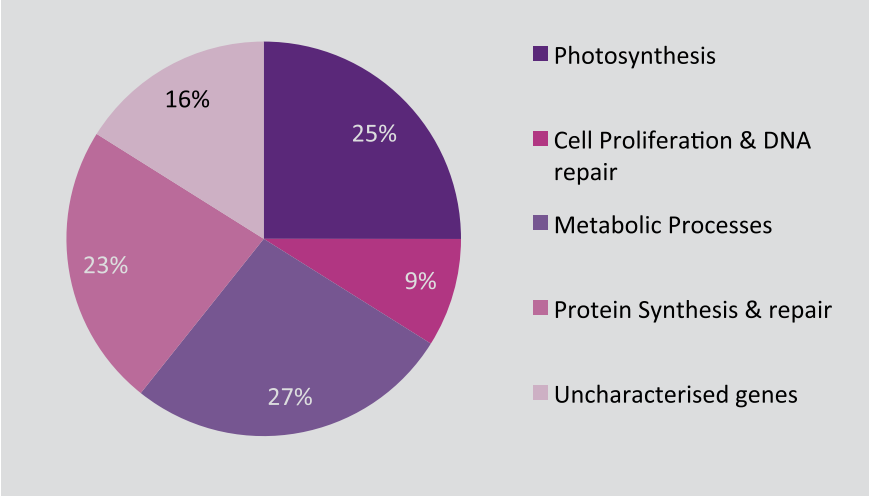
validation for salinity stress tolerance. *Tetreselmis* FBA was recombinantly expressed in *E.coli* cell; the recombinant cells acquired salinity tolerance when compared to non-recombinant cells. *Tetraselmis* FBA was functionally validated and found to be suitable transgene for Salinity tolerance

Acquired temperature and salinity tolerance in *E. Coli* through recombinant expression of peptidyl-prolyl cis-trans isomerase (FKBP12) From microalgae *Scenedesmus sp.*

From the temperature and salinity tolerant microalgae *Scenedesmus sp*. a SSH library of differentially expressing genes under temperature stress was prepared. A total of 325 clones were randomly picked and sequenced and analysed. A total of 148 contigs were formed from 325 clones sequenced and these sequences were aligned with gene bank data using BLASTN and BLASTX programme. Out of the 148 contigs, most of the contigs (78%) had no significant similarity with the available sequences in NCBI, thirteen clones showed sequence similarity with ribosomal gene, remaining contigs showed significant sequence homology with functionally identified genes.

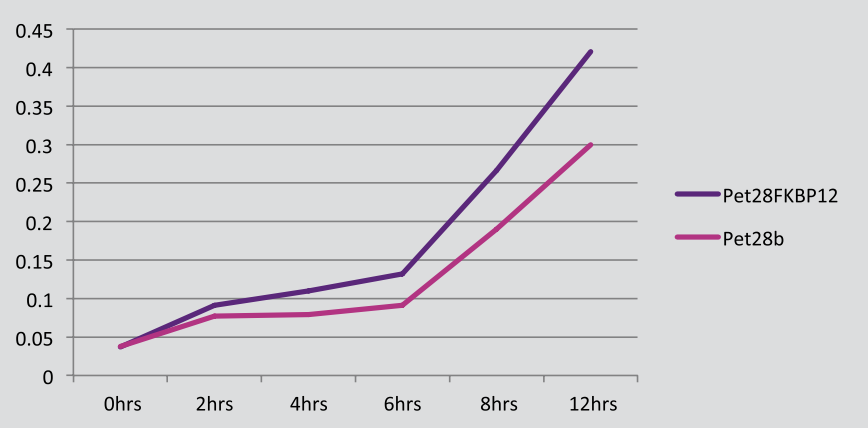


Classification of Scnedesmus. genes differentially expressed under hyper temperature shockosmotic stress

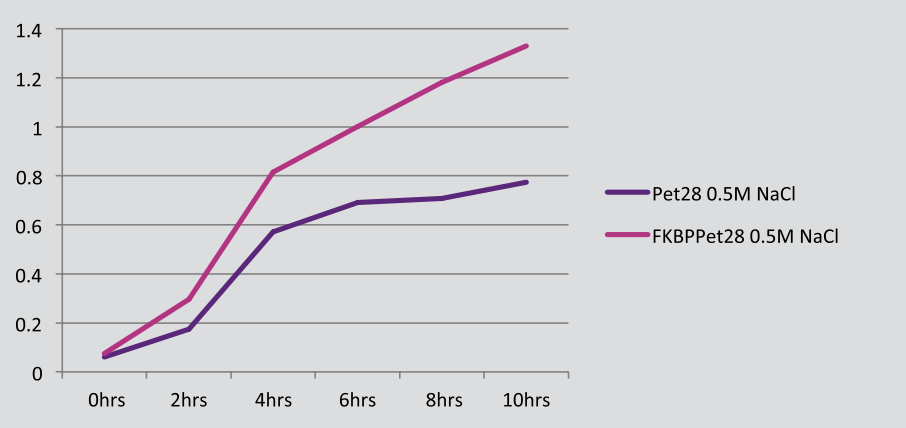


Functional classification of identified genes differentially expressed under hyper temperature shock

A peptidyl-prolyl cis-trans isomerase FKBP12 obtained during SSH assay was identified for functional validation for suitability to be used as a transgene. FKBP12 accelerates the slow rate limiting isomerisation step in protein folding. *Scenedesmus*FKBP12 was recombinantly expressed in *E.coli* cell; the recombinant cells expressing FKBP12 acquired tolerance for increased temperature and salinity. Thus *Scenedesmus*FKBP12 could be an ideal transgene for imparting temperature and salinity tolerance in plants.



The growth pattern of *E. coli* cells transformed with pET28FKBP12 and empty pET28b under temperature shock



Growth curve of recombinant *E.coli* cells with pET28FKBP12 gene and pET28 (control) under hyper osmotic stress

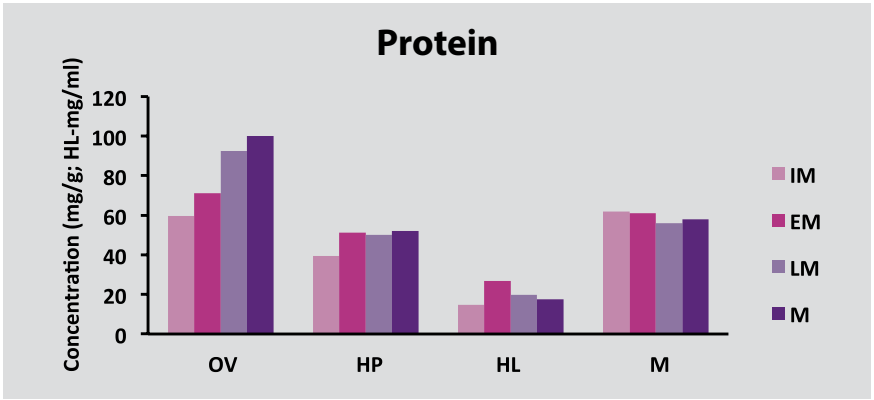
Reproductive Physiology of Sand lobsters

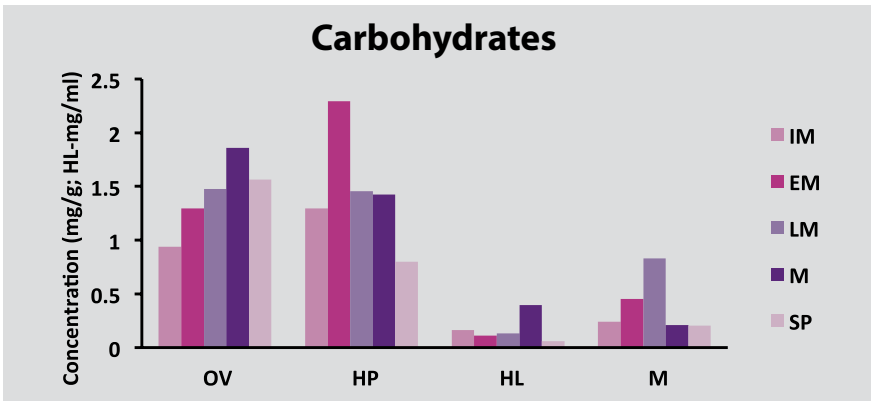
Research project: FISHCMFRISIL201202800028

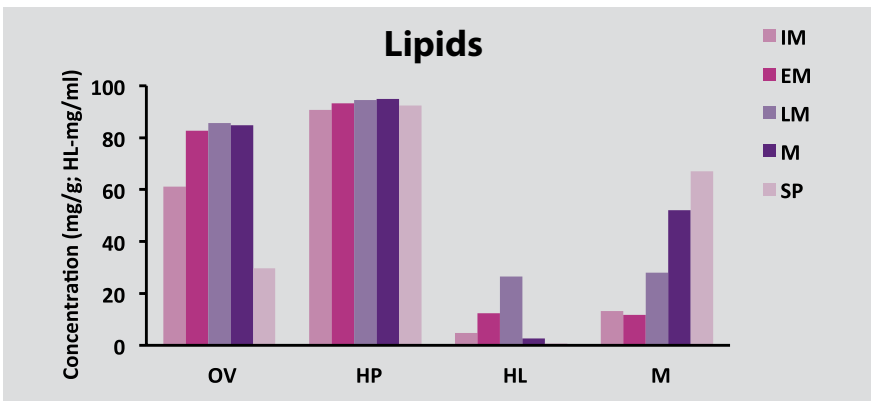
Sand lobsters, *Thenus unimaculatus* at various stages of the ovarian cycle were sampled from the wild and a complete classification of the reproductive stages has been made based on morphological observations and histological analyses. Quantitative changes in the biochemical constituents in tissues and hemolymph during ovarian development were also determined. Protein, lipid and carbohydrate concentrations in the ovary increased as gonad development progressed, with maximum levels being observed at the fully mature stage. Lipid content was highest in the hepatopancreas compared to other tissues in all reproductive stages. Conversely, protein and lipid levels in the hemolymph increased steadily in the initial stages, and then showed a decrease in the later stages of

maturation. Hemolymph acts as a medium to transport yolk protein from the synthetic sites to the ovary during maturation, and a decrease in protein and lipid concentrations from early to mature stage probably reflects its rapid uptake by the developing ovary. An experimental setup for assessment of eyestalk ablation impacts on molting/growth and gonadal development of sand lobsters was designed. Histological observations of eyestalk sections from control animals were made.

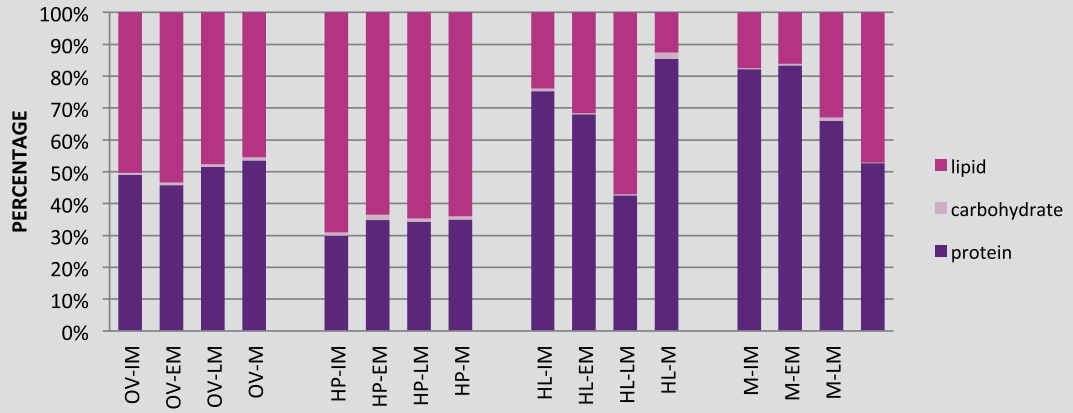
Osmolality changes in hemolymph of juvenile and adult sand lobsters, *Thenus unimaculatus* at intermolt stage in various salinities (28-38 ppt) after chronic exposure, were assessed to understand the animal's tolerance and adaptive ability to salinity stress. Lobsters showed a narrow range of osmotic tolerance.



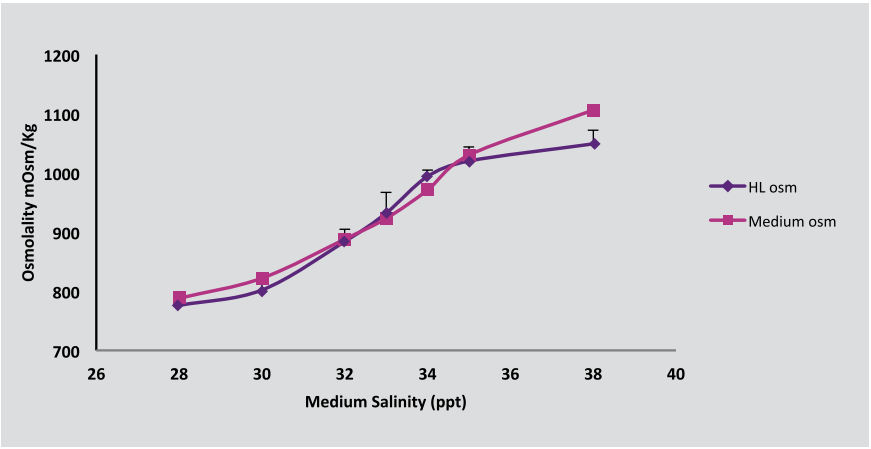




Changes in biochemical constituents of tissues (OV-ovary; HP-hepatopancreas; M-muscle) and hemolymph (HL) during ovarian development in the sand lobster, *Thenus unimaculatus*. Ovarian stages: IM-immature; EM-early maturing; M-maturing; FM-fully mature; SP-spent



Percentage composition of protein, carbohydrate and lipids (OV-ovary; HP-hepatopancreas; M-muscle and hemolymph- HL) during ovarian development in the sand lobster, *Thenus unimaculatus*. Ovarian stages: IM-immature; EM-early maturing; M-maturing; FM-fully mature.

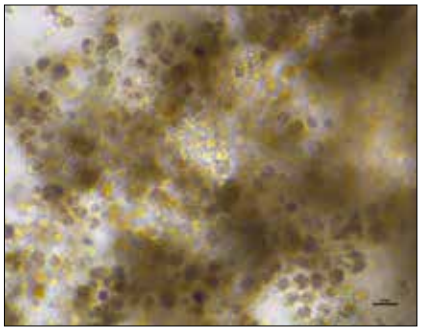


Hemolymph osmolality (mOsm/kg) in the sand lobster, *Thenus unimaculatus* in varying salinities (n=24)

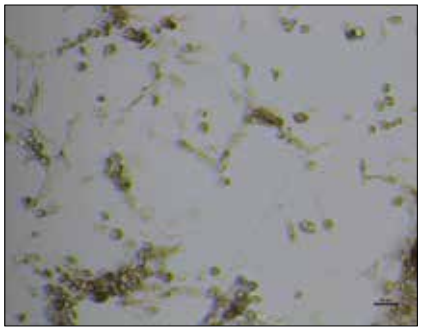
Bivalve tissue culture

Research project: FISHCMFRISIL201202900029

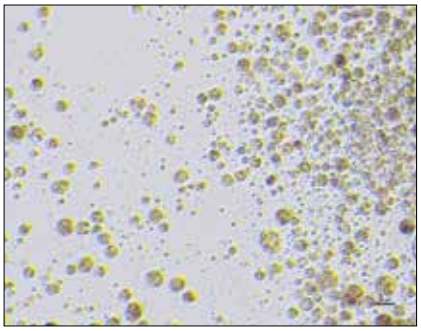
A long-term primary culture of mantle epithelial cells was established using sterile sea water as a basic medium for tissue culture of the green mussel *Perna viridis* and the black lip pearl oyster *Pinctada margaritifera*. Supplementation of the medium with yeast extract could encourage better cell migration and support tissue cell survival up to 2 months with periodic sub-culturing. Cell size was also bigger in seawater supplemented with yeast extract (15.85 µm and 19.05 µm in *P. margaritifera* and *P. viridis*, respectively), when compared to plain medium (13.82 µm and 11.50 µm in *P. margaritifera* and *P. viridis*, respectively), after 15 days of incubation. The formation of pseudopodial cell networks with granulated epithelial cells containing clusters of granules was achieved at around 14 days of culture. These cells increased in size with increasing period of culture, before liberating the granules. Some of these granules exhibited a pinkish purple hue resembling the inner shell layer (nacre) of the animals. After being released from the mature granulocytes, these granules became seeding sites for mineralization and induced formation of nacre crystal deposits on the bottom of the culture plate. Scanning Electron



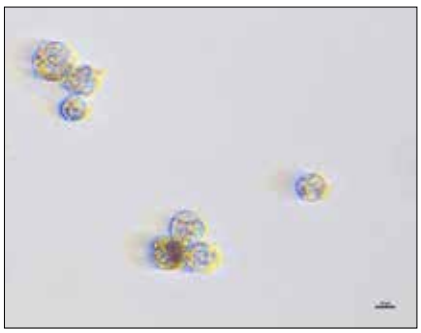
Perna viridis : Mantle tissue liberating epithelial cells in vitro



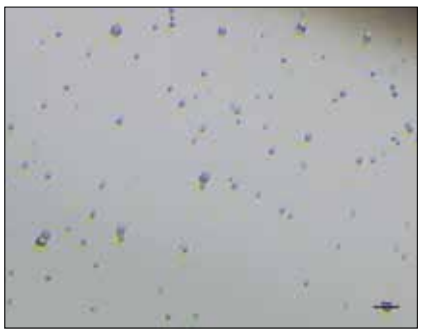
Formation of pseudopodial cell networks with granulated epithelial cells



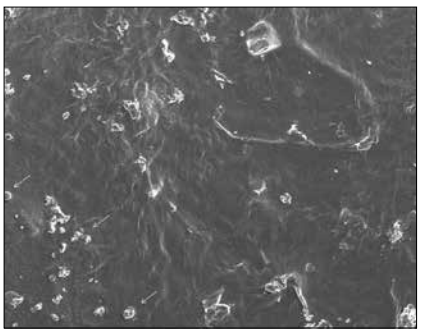
Granulated epithelial cells and released granules



Pinctada margaritifera : Granulated epithelial cells containing clusters of coloured granules



Released purple granules deposited on bottom of culture plate

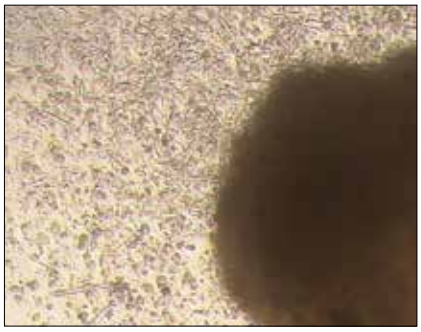


SEM micrograph of mantle explant (arrows indicate calcium deposits)

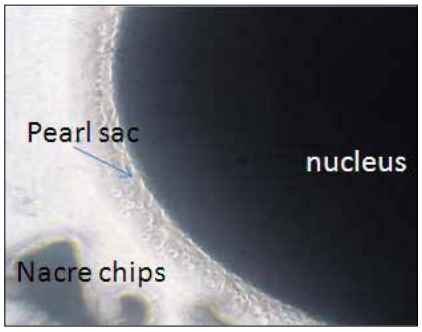
Microscopic (SEM) investigation of mantle explant showed a fibrillar surface with different sized mineral-like structures on it. Additional investigation of the chemical composition of the structures by an energy dispersive X-ray analysis (EDAX) revealed the presence of calcium which is a component of nacre crystal.

Cell proliferation was studied in the pearl oyster, *Pinctada fucata* using sea water and M199 as culture media. Proliferation was higher (20.5 x 10^4 cells/ml) in M199 supplemented with 25% supplementary salt solution, 10% FCS and 5% lactalbumin hydrolysate, when compared to sea water alone (7.2 x 10^4 cells/ml), on the 4th day of culture. However, less contamination and higher proliferation rates were noted in sea water after 15 days. Organ culture of mantle tissue from pearl oyster was done with combinations of seawater and M199 media with or without supplements FCS and lactalbumin hydrolysate in agar base, with pearl oyster shell pieces and crab shell pieces placed near the nucleus to study its effect on cell growth and pearl sac formation from mantle explants. Good pearl sac and nacre like formation was noted in one of the cell wells with sea water medium and pearl oyster shell piece. Explant culture of mantle tissue from pearl oyster was continued in both media incorporated with combinations of supplements such as water soluble matrix (WSM) prepared from shell, body fluid of oyster and lyophilized microalgal powder. Good number of cells was liberated in almost all combinations except in those where WSM alone was added in media. A matrix-like formation was noted around the explants in these cultures. Maximum numbers of cells of 45.69 and 41.13 x 10^4 cells/ml were released in sea water supplemented with microalgal powder and WSM, and sea water supplemented with M199, microalgal powder and WSM, respectively.

The study highlights the prospects of using sterile seawater with supplements as an alternative medium for establishing primary cultures and inducing



Mantle culture in pearl oyster, *Pinctada fucata* : Proliferation of cells in sea water



Formation of pearl sac

Formation of nacre on the nucleus

Liberation of cells in sea water supplemented with WSM and microalgal powder

Migration of cells from explant cultured in sea water supplemented with M199 ,WSM and microalgal powder

Formation of matrix in culture

nacre secretion in mantle tissue epithelial cells cultured *in vitro*, in place of expensive commercial media.

Cell culture of muscle tissue

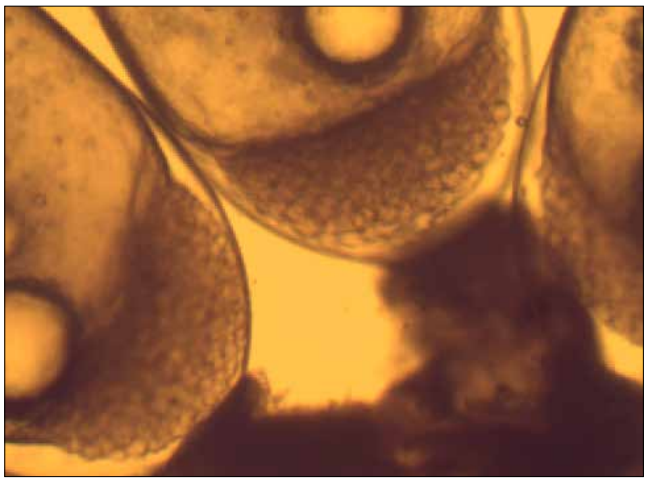
Adductor muscle tissue was excised from the pearl oyster and treated in antibiotic solution and washed thoroughly in sterile sea water. The tissue was cut into small pieces and inoculated in cell well with media M199 and sea water. Proliferation of cells of size 2-10µ and filaments were noted in the culture.

Cells released from the muscle tissue of *Pinctada fucata*

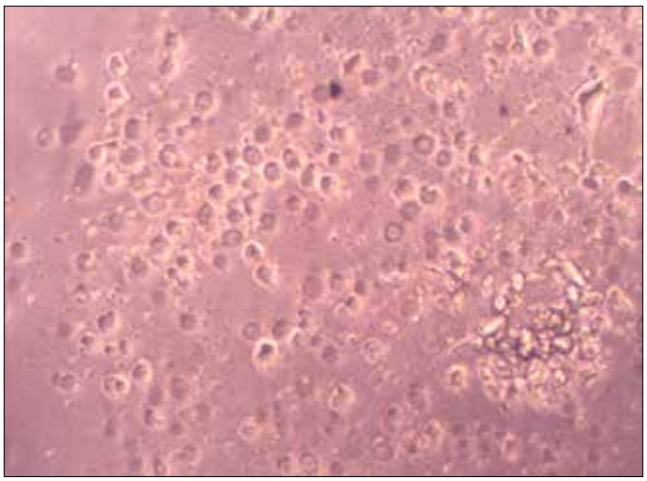
EMBRYONIC STEM CELL CULTURE

Research project: FISHCMFRISIL201203100031

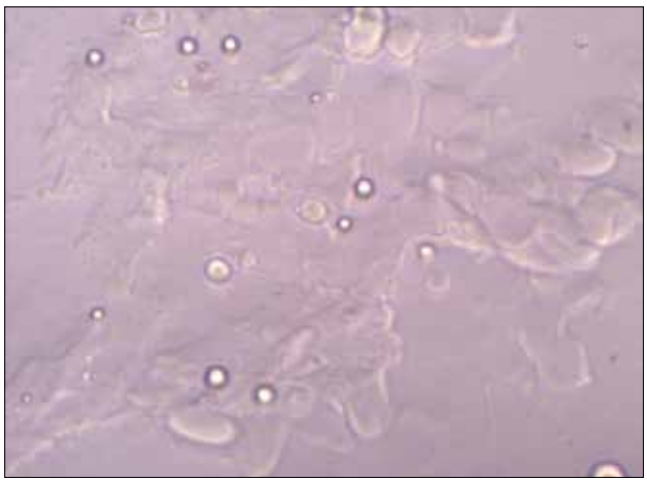
In vitro cultures of blastomeres isolated from 256 cell stage embyos of *Amphiprion ocellaris* were grown in LDF medium with 10% FBS in 12 well cell culture dishes under feeder free conditions with gelatin coating. Growth factors such as bFGF, FGF-2 and LIF were tested along with/or without embryo extract for efficacy on formation of stem cell colonies. Basic fibroblast growth factor (bFGF) was found to be the best for formation of typical stem cell colonies. Successful primary ES cell cultures were obtained in each trial, however, with poor attachment on subculture and passage.



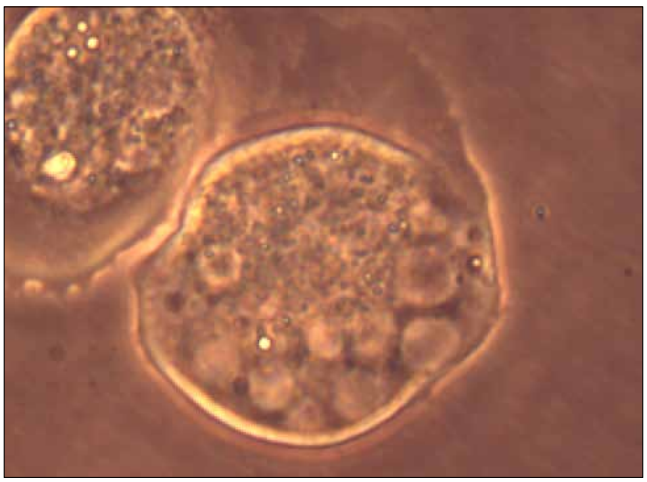
256 cell stage of *A. ocellaris* embryo (6:30 h post-fertilisation)



Blastomere attachment



Blastomere attachment and multiplication



Fibroblast cultures from *Epinephelus malabaricus* for deriving induced pluripotent stem cells (iPSCs)

Fibroblast cultures were initiated from spleen (EM5Sp1Ex), fin (EM5F1Tr) and gill (EM5G1Ex) tissues of *E. malabaricus.* Primary cultures initiated were sub cultured and the initial passages stored in liquid nitrogen for use in iPSc derivation. Attempts to re-programme low passage fibroblast cultures using pluripotency transcription factors are being undertaken.

FISH NUTRITION

Functional feeds

Research Project: FISHCMFRISIL201202700027

A study was conducted to investigate the influence of long pepper on maturation, breeding and reproductive performance of *Etroplus suratensis*.

Long pepper is an unripe spike of *Piper longum* Linn., a slender aromatic perennial climber belonging to the family *Piperaceae*. The roots and fruits (unripe spike) contains piperine and pipalatine alkaloids.

The objectives of the study were (1) to evaluate the reproductive performance of *Etroplus suratensis* fed with long pepper and (2) standardize the inclusion level of long pepper in broodstock diet of *E. suratensis*.

The feed formulation which resulted in optimum growth in an indoor trial conducted earlier was used to formulate experimental diets. Long pepper was incorporated at 0, 0.5, 1, 1.5 and 2.0 percent in the formulation ash shown in Table 1 below.

All ingredients were finely ground and thoroughly mixed with water to make a dough which was steam cooked for 10 minutes in a cooker. The cooked dough was pelletized in a hand pelletizer through 2 mm die, dried and stored in airtight containers. As the hand pelletized feed was found to be less water stable due to low starch content in the formulation, it was pulverized and then extruded (65-70 ^{o}C barrel temperature and 550 rpm screw speed) to obtain protein gelling. The extruded feed was found to be water stable which was slow sinking. Ingredient compositions of the experimental diets are shown in Table 1. below. The extruded feed crushed and sieved though 1 mm was used for feeding which is the appropriate particle size suitable for feeding these fish.

The proximate analyses of the feeds are given in Table 2 below. Evidently, the feeds are isonitrogenous and isocalorific.

Adults of *E. suratensis* procured from a private fish farm in Kadamakudy, were transported to the wet laboratory of the Institute in big circular containers with sufficient aeration. They were carefully transferred to another 100 L tank and left undisturbed, in order to ameliorate handling stress. The stock was acclimatized for 10 days to the laboratory conditions. Seventy five

adults (average weight, 50-53 g) were randomly distributed in triplicates following a completely randomized design (CRD). The six treatments were T1 control, T2 0.5 % long pepper (LP), T3 1.0 % LP, T4 1.5 % LP and T4 2.0 % LP. The experimental rearing system consisted of 15 uniform size tanks of 1000 L capacity with *in situ* biological filters. Fish were fed at 2% of the body weight. The daily ration was divided into two equal parts and fed at 10.00 am and 4.00 pm respectively. Uneaten feed and faecal matter were siphoned out daily.

A record of the initial weights, day on which pair formation was observed and days of spawning was maintained along with a check on water quality for temperature, pH, D.O and ammonia

The results of spawning success are presented in Table 3 below.

Table 1. Ingredient composition of experimental diets (g kg-1).

Ingredients	T1-C	T2-0.5LP	T3-1LP	T4-1.5LP	T5-2LP
Marine protein mixture[1]	410	410	410	410	410
Soy Flour[2]	410	410	410	410	410
Wheat Flour[3]	60	55	50	45	40
Sardine Oil[3]	60	60	60	60	60
Lecithin[4]	3	3	3	3	3
Vitamin C[5]	5	5	5	5	5
Vitamin Mixture[6]	20	20	20	20	20
Mineral Mixture[7]	30	30	30	30	30
Antifungal[8]	1	1	1	1	1
Antioxidant[9]	1	1	1	1	1
Long pepper[10]	0	5	10	15	20

[1]Equal mixture of Sardines (*Sardinella longiceps)* form Raj Fish Meal and Oil Co. Malpe,Mangalore, India, Jawala shrimp (*Acetes indicus*) from Hajee K. A. Abdul Kahader Sahib, Chennai, India, Meal of balck clam (*Villorita cyprinodis*) procured for local sea food market, Cochin, India)

[2]Sakthi Soyas, Coimbatore, India

[3]Food grade wheat flour form local market, Cochin, India

[4]Sardine oil from Kiriyathan Trading Company, Cochin, India

[5]Stay-C from DSM Nutritional Technologies, India

[6]Supplevite-M from Sarabhai Zydus Animal Health Pvt. Ltd, Vadodara, India

[7]Agrimin Powder from Vibrac Healthcare India, Pvt. Ltd., Mumbai, India

[8]Sodium metabisulphate from Nice Chemicals, Cochin, India

[9]BHT from Sisco Research Laboratories, Mumbai, India

[10]Long pepper (*Piper longum*) from local market, India

Table 2. Proximate composition (% on DM basis) and Gross Energy (GE) content of the experimental diets

	CP	EE	CF	NFE	Ash	AIA	GE MJ Kg-1
T1-C	50.84	8.81	0.14	23.74	16.47	4.07	18.39
T2-0.5LP	50.25	9.19	0.31	23.57	16.67	3.90	18.39
T3-1LP	49.69	9.18	0.11	24.23	16.80	4.00	18.37
T4-1.5LP	49.95	9.20	0.34	23.47	17.05	4.12	18.31
T5-2LP	49.74	9.13	0.36	23.44	17.33	4.05	18.23

Within a week pair formation was observed in control (T1-C) and T3-1LP tanks. There was no pair formation in the remaining treatments which are, T-2-0.5LP, T4-1.5LP and T5-2.0LP. Spawning resulted in the feed treatment T3-1LP on day 69, 82 and 85 respectively, repeatedly in the same tank. Spawning occurred once in T1-C also on day 80.

Table 3.Spawning record in response to dietary treatments

Treatments	No. of spawnings	After days of treatment
T1-C	1	80
T2-0.5LP	0	
T3-1LP	3	69, 82 and 85
T4-1.5LP	0	
T5-2LP	0	

Spawning of Etroplus suratensis fed long pepper containing (1 %) feed

Custom made marine fish feeds: Floating marine fish feeds with 40 % protein and 10 % fat manufactured and supplied by M/s Growel Feeds, Andhra Pradesh were evaluated in pompano seeds supplied from Mandapam in farmers cages in Mandapam and Cochin. In both cases mortalities were noticed which are investigated. In batch of feeds supplied to Cochin, aflatoxin B_1 detected was 1.5 µg kg^{-1}. In feeds supplied to Mandapam aflatoxin was not detected. Histopathological investigations are being carried out. Proximate composition of the feed is given in the Table below which indicated 40% protein and 10% fat required in marine fish feeds

Proximate composition of custom made marine fish feed by Growel (% As fed)	
Moisture	6.47
Crude Protein	40.17
Crude Fat	9.90
Crude Fiber	0.94
Soluble Carbohydrates	27.80
Ash	14.71
Acid Insoluble Ash	0.87

Lipase catalysed enrichment of C22 long chain fatty acids from the urea fractionated Poly Unsaturated Fatty Acid (PUFA) concentrate

The refined sardine oil was found to contain long-chain polyunsaturated fatty acids (LC-PUFAs), particularly eicosapentaenoic acid (20:5 *n*-3 or EPA; 17.80 ± 1.57 % of total fatty acids, TFA) and docosahexaenoic acid (22:6 *n*-3 or DHA; 7.67 ± 1.50 % of TFA). The PUFAs containing $C_{18\text{-}C22}$ acyl chain length contributed a major share of the total fatty acids of the sardine oil (>30 % TFA). EPA and DHA were found to be the major *n*-3 PUFAs contributing to 17.8 % and 7.67 % of TFA, respectively.

The fatty acid concentrate derived by urea fractionation resulted in higher content of DHA (~20 %) when crystallized at 2°C. Consequently, DHA obtained from sardine oil at 2°C temperature of urea-crystallization by using a U/FA ratio of 3:1 selected for subsequent purification of DHA.

The variations of PUFA content of sardine oil triglycerides as a function of time during the lipase-catalysed hydrolysis were also studied. The total DHA of fatty acyl ester fraction increases with time up to 3 h of lipase-catalysed hydrolysis (35.27 % TFA), beyond which it slowly decreased (9.81 % TFA after 9 h). The purified lipase was able to enrich DHA with 35.27 % 22:6*n*-3 after 3 h of hydrolysis.

The results suggest that the esteritic bonds of C_{22} acyl chain lengthened *n*-3 PUFAs are resistant to hydrolysis by the lipase. After prolonged hydrolysis (>9 h), when only a few target fatty acid ester bonds (*n*-6 fatty acyl ester bonds and esters other than C_{22} *n*-3 fatty acids) are available in the enzyme hydrolysate that are susceptible to hydrolysis by a lipase, the microbial lipase can even cleave bonds that are resistant (or nearly resistant) to hydrolysis. Therefore, it is be possible to separate and concentrate C_{22} PUFAs with *n*-3 double bonds like DHA using lipase from seaweed associated *Bacillus subtilis*.

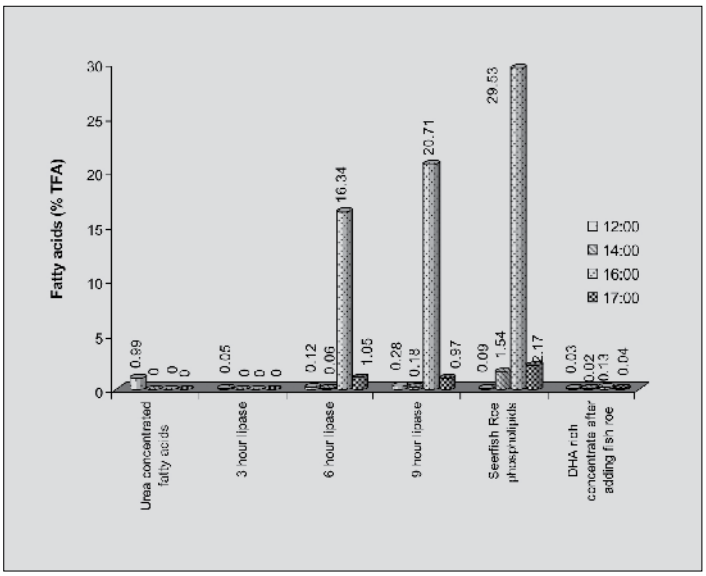
Fatty acid composition of candidate microalgal species for use in mariculture

Research Project: EF-30/ICAR Outreach Activity 2 - Fish Feeds

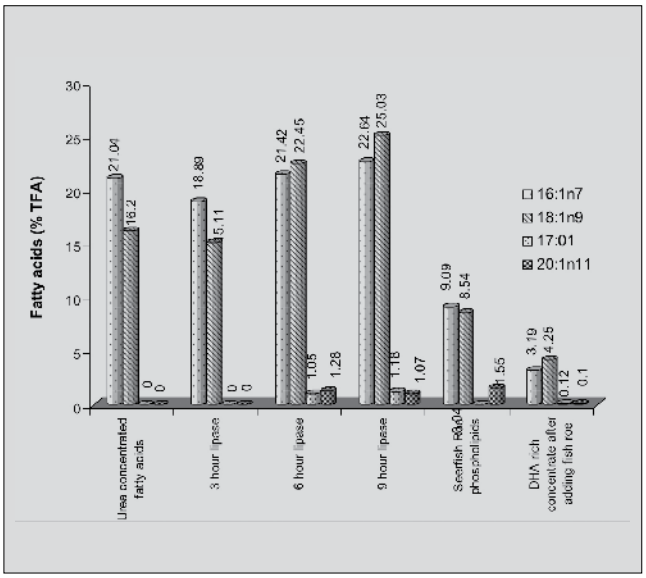
A total of 18 available microalgae strains were profiled for fatty acids. Three each of microalgal strains belonged to the genera *Nannochloropisis* (RA_{01}, RA_{02} and RA_{05}), *Isochrysis* (RA_{06}, RA_{09}, RA_{10}) and *Tetraselmis* (RA_{17}, RA_{18}, RA_{19}); two species from *Chlorella* (RA24, RA26), *Chaetoceros* (RA35, RA40) and *Pavlova* (RA_{45}, RA_{46}), whilst one each from *Dicrateria* (RA_{14}), *Dunaliella* (RA_{20}) and *Picochlorum* (RA_{47}) were profiled. Most microalgal species have

moderate to high percentages of EPA (7 to 34 %).

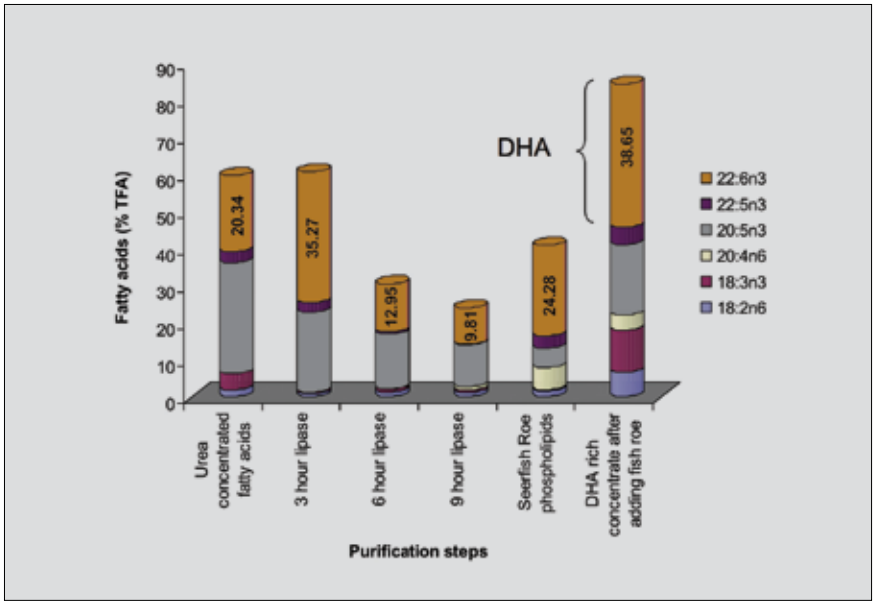
Prymnesiophytes (e.g. *Pavlova* and *Isochrysis* and cryptomonads are relatively rich in DHA (0.2 to 11 %), whereas eustigmatophytes (*Nannochloropsis*)



Saturated fatty acids at different steps of purification

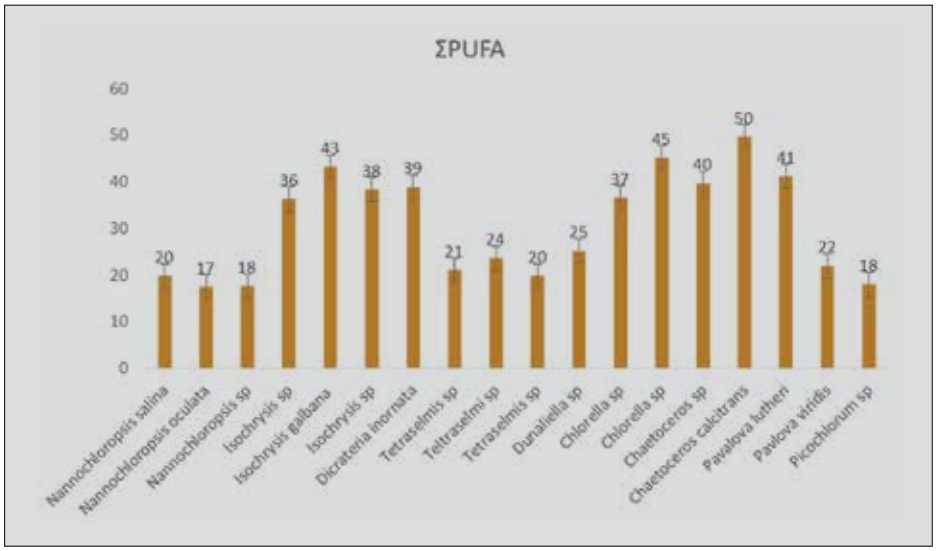


Monounsaturated fatty acids at different steps of purification



Polyunsaturated fatty acids at different steps of purification

and diatoms have the greater contents of arachidonic acid (ARA) (0 to 4 %). Chlorophytes (*Dunaliella* and *Chlorella*) are deficient in both C_{20} and C_{22} PUFAs, although some species have small amounts of EPA (up to 3.2 %). Baker's yeast was deficient both in DHA and EPA. *N. oculata* was rich in EPA and ARA. Among the different experimental microalgae, *Chaetoceros calcitrans* (RA_{40}) was found to contain the greater content of aggregate polyunsaturated fatty acids as compared to other microalgal species.

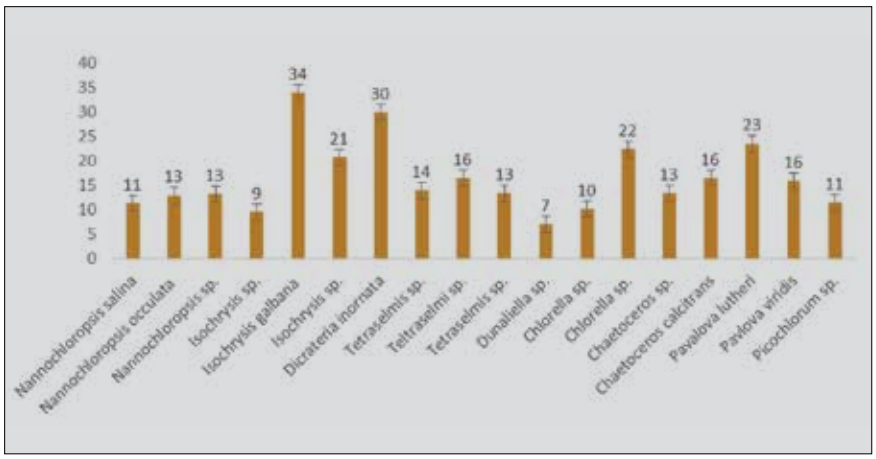


Differential content of PUFA (% TFA) in the candidate microalgal species

Isochrysis galbana (RA_{09}), *Pavlova lutheri* (RA_{45}), and *Chlorella* sp (RA_{26}), which also recorded an aggregate content of greater than 40% polyunsaturated fatty acids. It is interesting to note that the *n*-6 fatty acids in *Chlorella* sp (23 - 36%) contributed the predominant share among the total polyunsaturated fatty acids content. The total content of *n*-3 fatty acids was found to be greater in *Isochrysis galbana* (RA_{09}) and *Dicrateria inornata* (RA_{14}) (30 - 34%). The DHA content of *Isochrysis* (RA_{06}, RA_{9} and RA_{10}) (7 - 10%) was found to be greater than other species recorded in the study, whereas the total EPA content was found to be greater in *Nannochlropsis* (RA_{01}, RA_{02}, and RA_{05}) (11 - 12%), *Tetraselmis* (RA_{17}, RA_{18}, and RA_{19}) (9 - 11%), *Pavlova lutheri* (RA_{45}) (10%) and *Chaetoceros* (RA_{35}) (9 %), in descending order.

Fatty acid composition of rotifers enriched with experimental media

An assessment was made to compare the efficacies of commercially available live feed enrichment products with an indigenously developed import substitute. Rotifers were enriched with four different media. (1) Algamac - 2000 (Biomarine Inc., Aquafauna, USA) (2) Selco S.presso® (INVE Aquaculture) (3) Marine fish derived oil emulsion (4) *Cheatoceros* (RA 35)

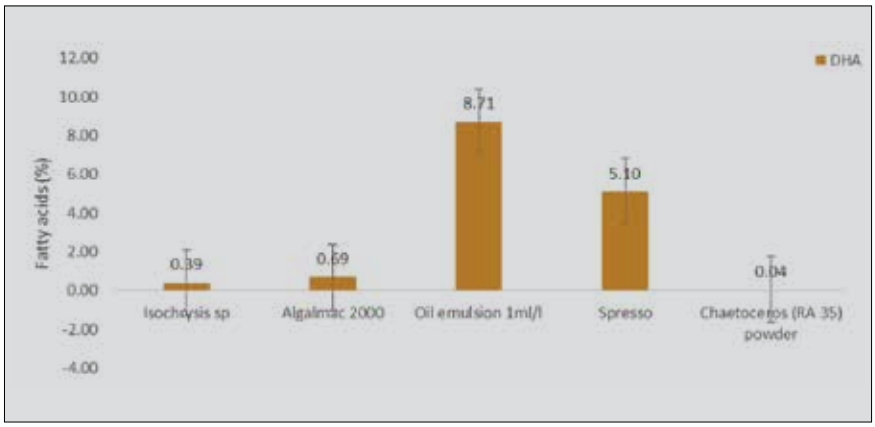


Differential content of aggregate n-3 PUFAs (% TFA) in the experimental microalgae

derived microagal powder and (5) unenriched rotifers (grown on microalgae (*Isochrysis galbana*).

Sardine oil enriched with DHA and EPA through biochemical and microbiological procedures were used to formulate enrichment emulsions which contained grossly 90% PUFA enriched fish oil and 10% lecithin extracted from roe of seer fish *Scomberomorus guttatus*.

Maximum DHA enrichment was with the marine fish derived oil emulsion developed indigenously.

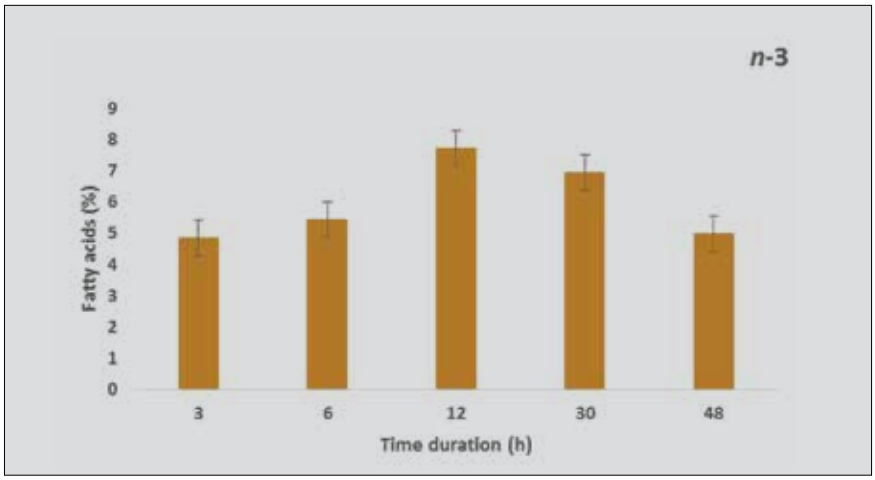


Differential content of DHA in the rotifers enriched with different experimental diets

The content of C_{22} *n*-3 fatty acid (DHA, 22:6*n*-3) in the rotifers was found to be significantly greater (9 %, used at a concentration of 1 mL/L) than those with different enrichment media used in the present study were with (~ 0.4, 0.7, 0.04 and 5.01 %) in *I. galbana*, Algamac 2000 (Biomarine Inc., Aquafauna, USA), S.presso (Selco S.presso ®, INVE Aquaculture) and Algal powder (RA_{35}), respectively.

The duration of enrichment of rotifers with *I. galbana* resulting in maximum *n*-3 PUFA was found to be 12 h as shown in the Figure below.

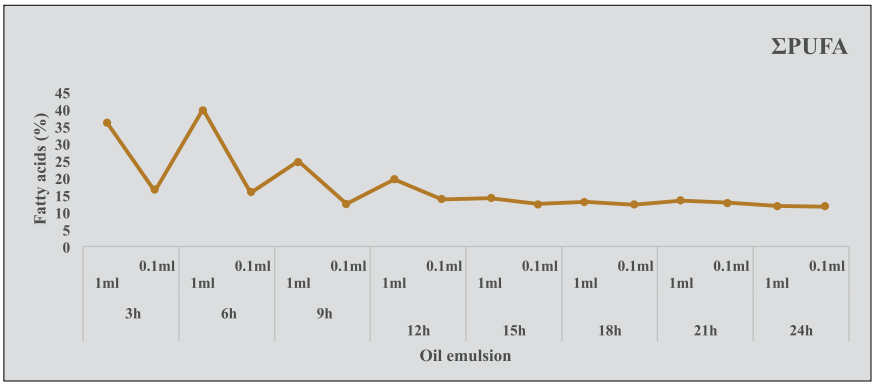
Duration of enrichment with marine fish derived oil emulsion was leading to maximum enrichment of DHA and EPA was evident at 6 h as shown in figures below.



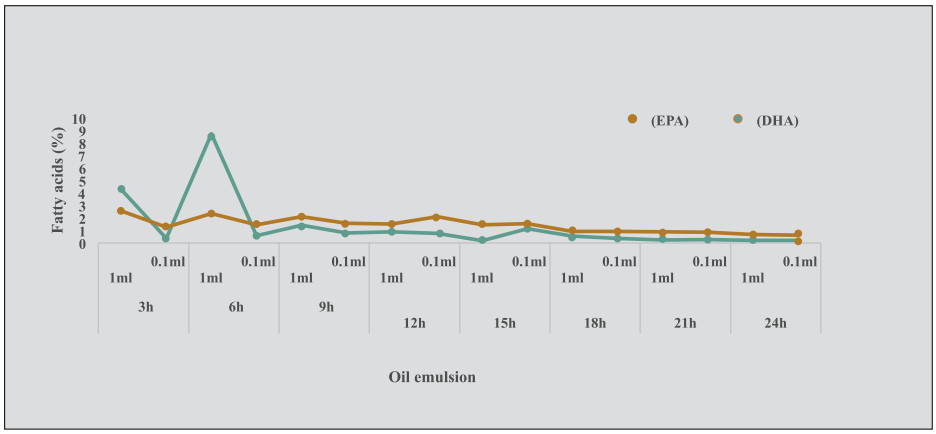
Differential content of n-3 long chain PUFA of *I. galbana*

Effect of enriched rotifers on the growth and survival of the clownfish larvae Amphiprion ocellaris

The same enrichment treatments were evaluated in the larval survival of *Amphripion ocellaris*. The survival percentage of the fish larvae was



Differential content of PUFA in the rotifers (*Brachionus plicatilis*) enriched with oil emulsion



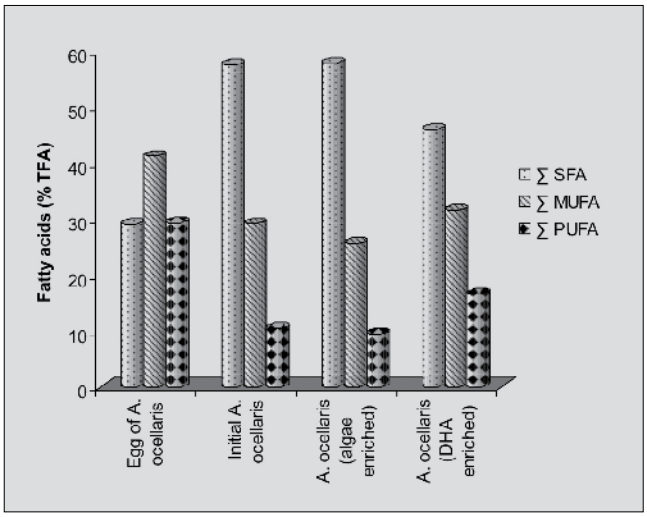
Differential content of EPA and DHA in the rotifers enriched with oil emulsion

maximum (89 %) when they were fed with rotifers originally enriched with the indigenously developed marine fish derived oil emulsion. The survival of the ornamental fish larvae were found to be lower when rotifers enriched with the algal powder (R_{35}) (76 %), Algamac (81 %) and S.presso (86 %). Thus, the indigenously developed oil emulsion is a valuable import substitute in marine larval nutrition.

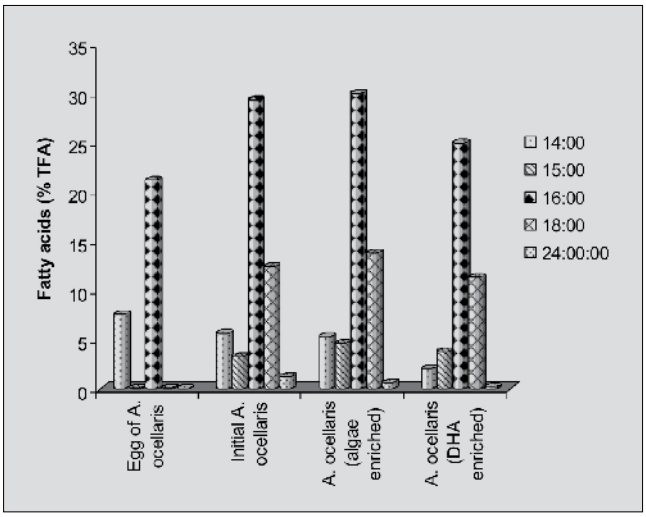
A. ocellaris larvae were found to contain a total of 57 % saturated fatty acids (SFA) and 10 % PUFA. The total content of DHA was recorded to be less than 2 % of fatty acids. The DHA content of the larvae of *A. ocellaris* was found to increase to 6.7 % from the initial value of 1.34 % after feeding the larvae with the rotifers, which were enriched with the oil emulsion developed in the present study. No significant increase in the content of the long chain C_{20-22} fatty acid was apparent when the larvae were grown in the algae alone. The indigenously developed DHA enriched oil emulsion developed in this study can therefore potentially substitute the imported products available in the market for marine fish larviculture.

Fatty acid composition of microalgal powder

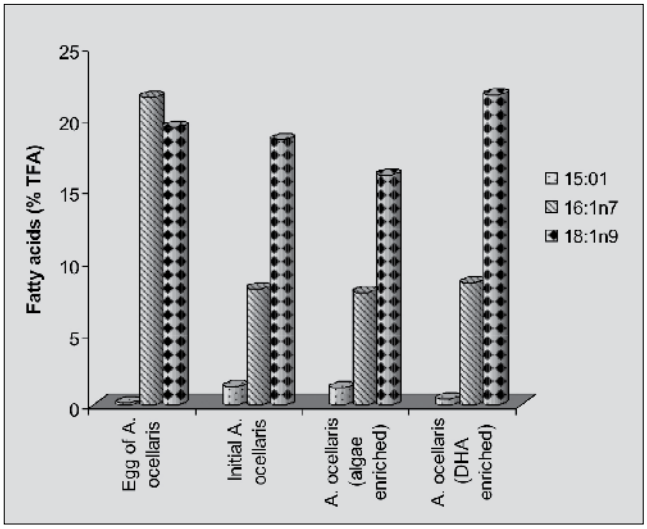
From the profiling of fatty acids of marine microalgae, the culture of *Chaetoceros* (RA_{35}) was selected based on their balanced composition of necessary fatty acids (EPA, AA, and DHA). The filtered sample was initially lyophilized to remove the moisture, which was thereafter used as rotifer enrichment media. This species was shortlisted to develop a live feed (rotifer) enrichment formulation due to its balanced proportion of ARA (7.45 %), EPA(9.15 %) and DHA (5.28 %). The present study attempted to development of a cost-effective microalgal powder.



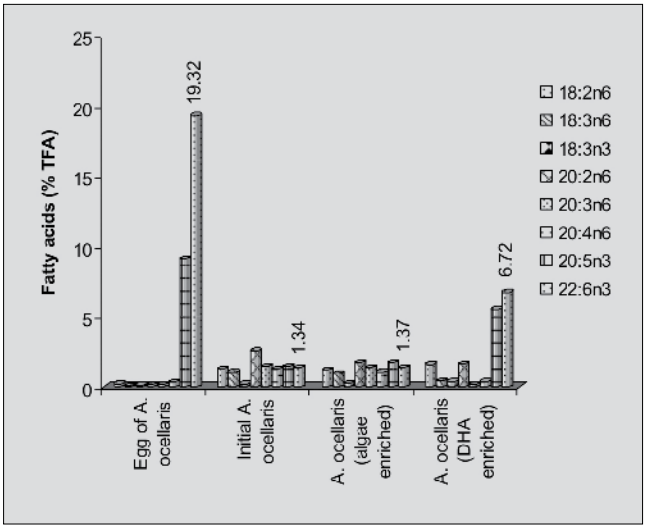
Fatty acid composition of A. ocellaris and that enriched with DHA-enriched rotifer



Saturated fatty acids



Monounsaturated fatty acids

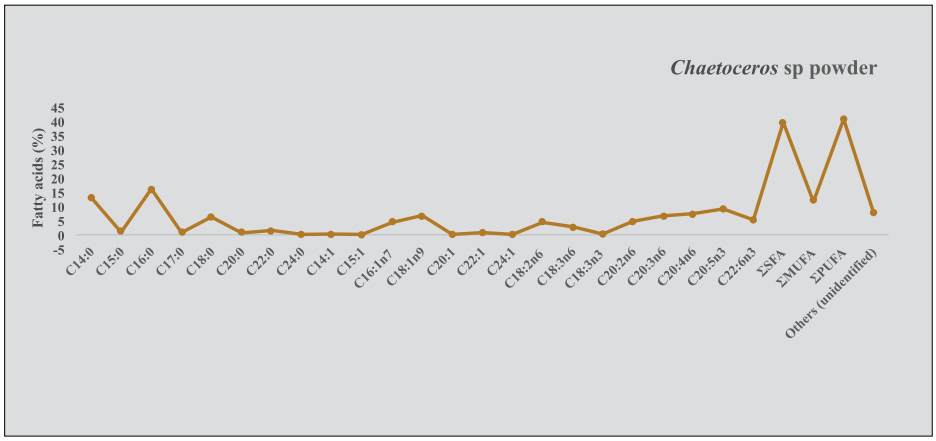


Polyunsaturated fatty acids composition of *A. ocellaris* and that enriched with DHA-enriched rotifer

Nutritional qualities of common edible cephalopods

Research Project: EF-29/ICAR Outreach Activity 3 - Nutritional profiling and evaluation of fish as a dietary component

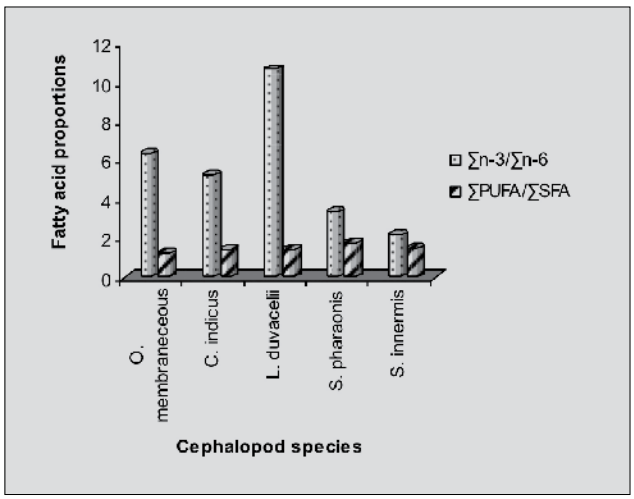
Amphioctopus neglectus was found to contain greater quantities of sulfur



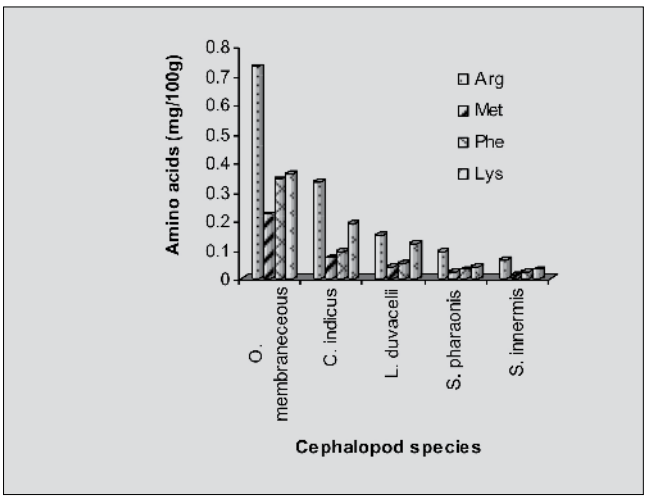
Fatty acid composition of Chaetoceros powder

containing amino acids (0.23 mg/100 g) and lysine (0.36 mg/100 g) than other cephalopods. The long chain *n*-3 fatty acids, for example, EPA and DHA, were found to be predominant in the edible part of the cephalopod species (30-44 % total fatty acids). The aggregate EPA and DHA contents of 44 % total fatty acids (TFA) of the edible parts of *Euroteuthis (P) duvauceli* was found to be significantly greater than other species of cephalopods (30-37 %TFA). Appropriately, the *n*-3/*n*-6 polyunsaturated fatty acid proportion of *E. duvauceli* was found to be significantly greater (~10, P<0.05) than those in the edible parts of other cephalopods. The mean total of *n*-3 PUFA content (33-46 % TFA) was found to be greater compared with *n*-6 PUFA (4-15 % TFA) in cephalopods. The major *n*-6 PUFAs were found to be 18:2*n*-6, 18:3*n*-6 and 20:2*n*-6.

The cephalopods contained protein with balanced proportions of essential to non-essential amino acids (~1.5.). Among the different cephalopod species, *Amphioctopus neglectus* exhibited significantly greater (P<0.05) content of total essential amino acids (3.15 mg/100g wet weight) followed by *Cistopus indicus* (1.42 mg/100 g). The most abundant essential amino acid was found to be arginine in *Amphioctopus neglectus* (0.73 mg/100g wet edible tissue), followed by leucine (0.46 mg/100g) and lysine (0.36 mg/100g). Among the non-essential amino acids, glutamine was followed by aspartic acid. *Amphioctopus neglectus* showed significantly higher leucine/isoleucine proportion when contrasted with those in other cephalopod species (P< 0.05).



Fatty acid proportions of the edible parts of different cephalopod species



Essential amino acid compositions of the edible parts of different cephalopod species

FISH HEALTH AND MARINE BIOPROSPECTING

Disease investigations in finfishes

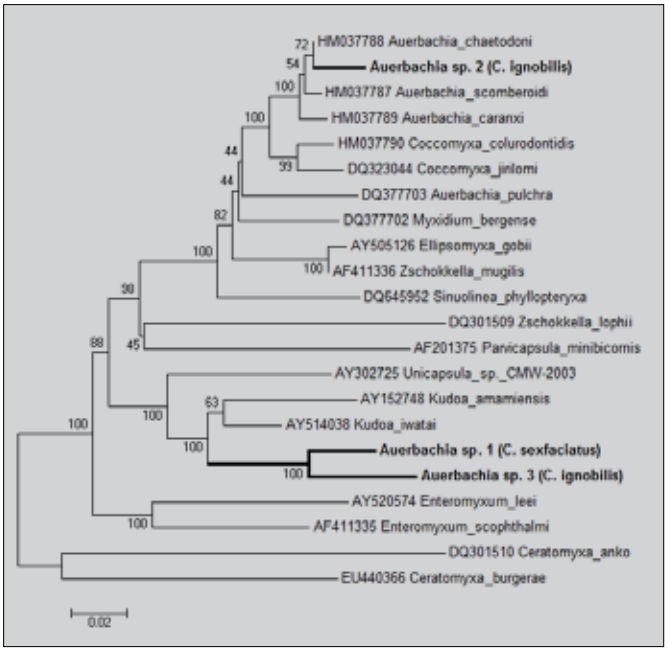
Research project: FISHCMFRISIL201202600026

Parasitic infections:

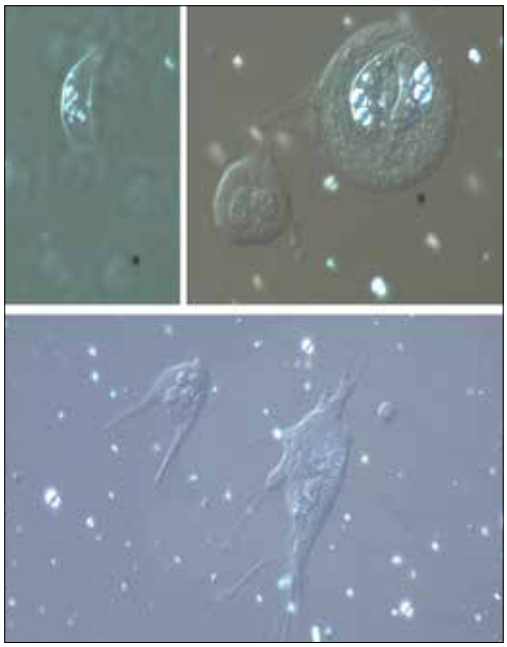
Myxosporean infections were reported from carangid fishes *(Caranyx sexfaciatus* and *Caranyx ignobilis)* collected from Cochin. The parasites belonging to the Genus *Auerbachia* were found infecting the gall bladder with spores disbursed in the bile; developmental stages of the parasites could not be observed.

Detailed taxonomic studies showed that all the 3 isolates exhibited varying degrees of morphological differences. *Auerbachia* sp. 1 from *C. sexfasciatus* and *Auerbachia* sp. 2 from *C. ignobilis* were more similar when compared to *Auerbachia* sp. 3 from *C. ignobilis* which differed significantly both morphologically and morphometrically. But, molecular phylogenetic studies based on the ITS region revealed a different picture, where *Auerbachia* sp. 1 and *Auerbachia* sp. 2 were grouped under 2 different clades. Genetic

Auerbachia sp. from Carangid fishes



Phylogenetic analysis of the different species of *Auerbachia*



Ceratomyxa diamanti from *Etroplussuratensis*- spores & developmental stages

Ceratomyxa collare n. sp.from Chaetodon collare

Cysts of *Henneguya* sp. on the stomach wall of Pompano

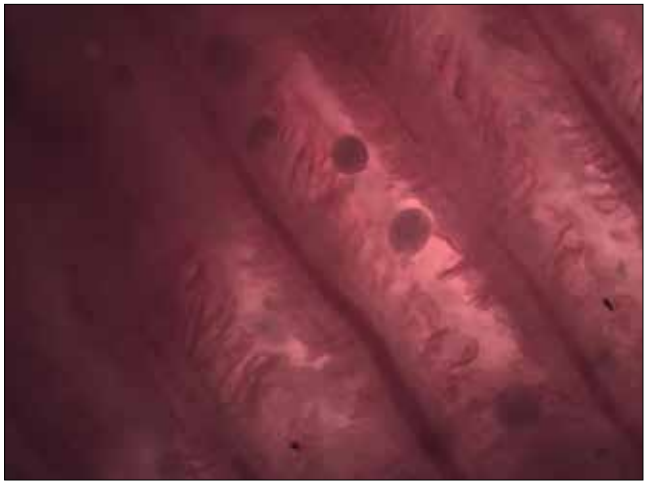
distance values also showed that though *Auerbachia* sp. 1 and sp. 2 showed morphological resemblance, at molecular level they stood apart, while *Auerbachia* sp 1 and sp. 3 though morphologically distinct, showed close resemblance. Morphometric and molecular taxonomy analysis showed that all the 3 recovered species are distinct from the already described species of *Auerbachia* and can be considered as new species.

Ornamental fishes collected from Vizhinjam, Kerala were screened for parasitic infections. Preliminary results indicated the presence of myxosporeans belonging to two families- Ceratomyxidae and Myxididae. Taxonomic analysis of the parasites revealed that the ceratomyxids included a new species infecting *Chaetodon* collare and *Chaetodon decussatus* with 66.67% prevalence. The parasite was systematically named as *Ceratomyxa collare* n. sp. after the specific name of the dominant host. Infections with *Ceratomyxa cardinalis* was recovered from *Abudefduf sordidus* and *C. falcatus* infections were observed in *A. saxatilis*.

Myxosporean infections were reported from *Etroplus suratensis* and *E. maculatus* from farms at Ernakulam. Molecular characterization revealed that the parasite belonged to the species *Ceratomyxa diamanti*. Infection with the myxosporidian, *Henneguya* sp. was reported from Pompano brood stock at Mandapam. Plasmodia/cysts were found attached to the wall of the stomach.

Heavy infestation with *Amyloodinium oscillatum* was reported from Asian seabass. Histopathologically, gills showed moderate to severe hyperplasia of primary and secondary lamellar epithelium, fusion of adjacent lamellae, separation of epithelium from underlying vascular spaces and cystic cavitation within the hyperplastic epithelium. *Amyloodinium* infestations leading to mortalities were also reported from various marine ornamental fishes.

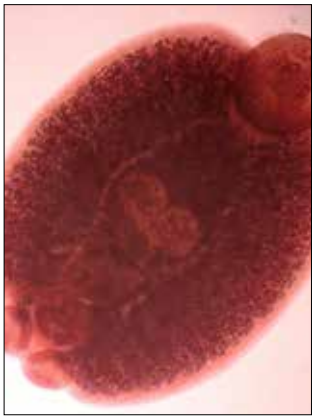
Severe infestation with the monogenean parasite, *Benedenia* spp. was recorded for the first time in the Indian pompano, *Trachinotus mookalee* broodstock reared at Visakhapatnam. The prevalence of infestation stood



Amyloodinium infestation on gills

Amyloodinium infestation in ornamental fish

Benedenia sp infestation in pompano



Benedenia sp.

Cirolanid isopod

Caligus sp. infestation in *Platax orbicularis*

at 100 % with a mean intensity of 131.23 ± 18.57 parasite per fish. Bath treatment in 30 ppm. formalin and freshwater for 15-30 minutes controlled the parasite. Infection with *Benedenia epinepheli* was also recorded in ornamental at Mandapam.

Tenuiproboscis sp. attached to the wall of the intestine

Infestations with cirolanid isopods in *Platax orbicularis* and *Caligus* sp. in *Pomacanthus semicirculatus* were reported from Vizhinjam.

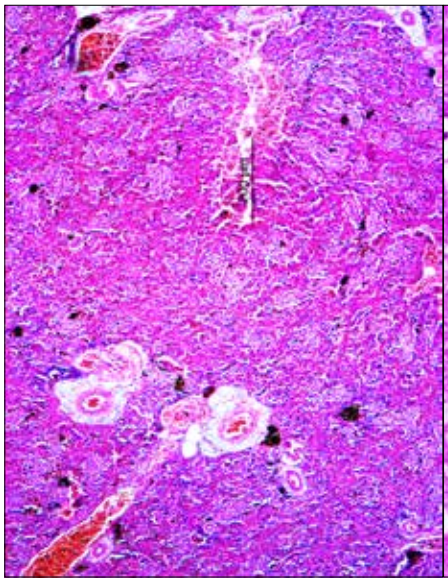
Screening of commercially important species of fishes (Red snapper, Groupers, Asian seabass, Scianids and *Gerres* sp.) from the coastal waters of Cochin revealed infections with the Acanthocephalan parasite, *Tenuiproboscis* sp. indicating a wide host range. Morphological variations were observed in parasites recovered from different host species. Molecular taxonomy studies using the ITS gene and subsequent phylogenetic analysis showed that irrespective of their host species, they were all genetically identical. Detailed study on the taxonomic affiliations showed that the present species differs from all the previously described species of *Tenuiproboscis* morphologically and morphometrically and can be considered as a new species.

Bacterial infections

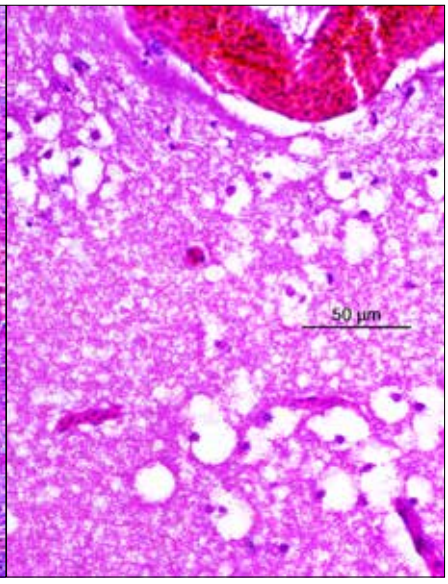
Mortalities in cage cultured cobia: Investigation of mass mortalities of cage cultured cobia fingerlings at Mandapam was investigated. Fish were off feed, clinical signs included surfacing and darkening of the skin leading to morbidity and mortality. Congestion and pin point haemorrhages were also observed. Bacterial isolation from the moribund fishes indicated *Vibrio*sis.

Congestion and haemorrhages in Cobia with Vibriosis

Gross specimen of cobia liver showing nodulations



Granulomatous lesions in the liver of cobia



Vacuolation in the brain of cobia

High mortality in cage reared cobia at Goa was attributed to infection caused by *Vibrio ponticus* and this forms the first report of *V. ponticus* isolation from India.

Viral infections

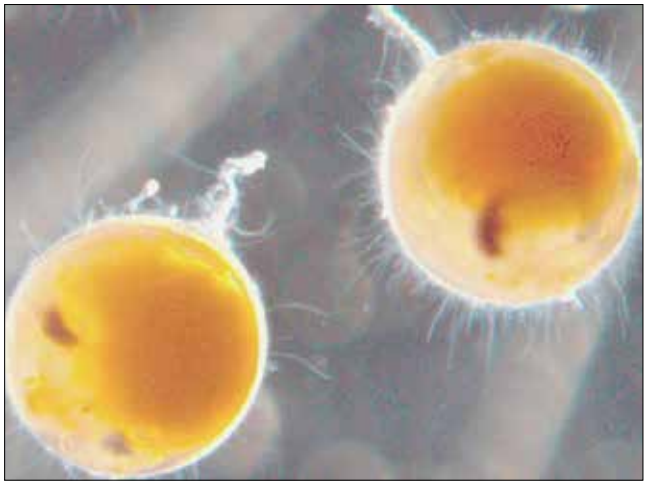
RT-PCR diagnosis indicated VNN as the etiological agent causing mortalities in cage reared cobia at Karwar. Typical granulomatous nodules were seen on the liver of infected fishes from which a gram positive bacteria, *Macrococcus*

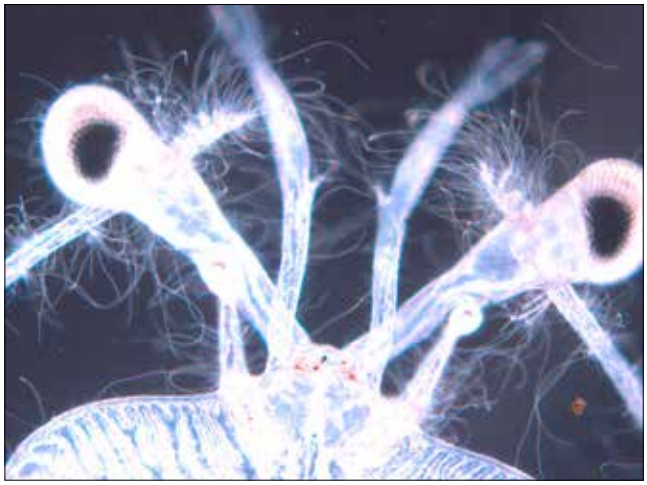
Lobster eggs infested with carcinonemertean worm

casenolyticus, confirmed by 16s r RNA sequencing, was repeatedly isolated. Histopathologically, extensive granulomas in the liver and increased expression of melanomacrophage centres in the kidney with necrosis of tubules were observed. The grey matter of the brain revealed extensive vacuolation.

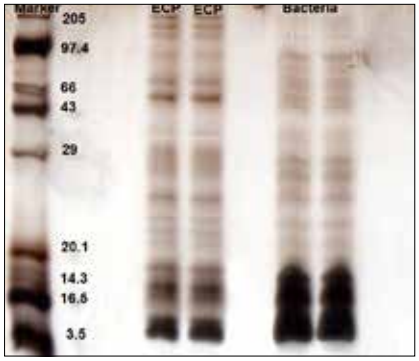
Diseases in lobsters

Infestation of the lobster eggs (*Thenus unimaculatus, Petrarctus rugosus, Panulirus homarus, P. ornatus* and *P. versicolor*) leading to premature shedding/discarding developing eggs was reported from the lobster breeding facility at Kovalam Field laboratory of CMFRI. Detailed examination of eggs/ clutch revealed infestation by a carcinonemertean worm. The infected eggs turn white and the worm consumes the developing egg completely, they





Filamentous bacterial infection in lobster eggs and larvae



SDS-PAGE protein profiling of bacteria and ECP of P. damselae sp. damselae

lay eggs inside the egg case, and larval forms swim out and attach to the surface of other lobsters. Nemertean worms were found to be major egg predators, causing severe losses in egg clutch during incubation, and female lobsters mostly discard the entire lot of eggs irrespective of the stage of embryonic development.

Phyllosomal mortality caused by luminescent bacteria *Vibrio harveyi* and filamentous bacterial infection in eggs and larvae were reported from Kovalam laboratory of CMFRI.

Characterisation of bacterial proteins

SDS Page profiling and silver staining of the extra cellular products of *Photobacterium damselae* ssp *damselae* from cage cultured cobia revealed

API ZYM enzyme profiling of ECP of *P. damselae* ssp *damselae*

the presence of 15 bands wherein compared to bacteria, 3 bands were repressed and two bands were over expressed.

API-ZYM assay both the ECP and bacteria were positive for the presence alkaline phosphatise, esterase, esterase lipase, leucine arylamidase, α-chymotrypsin, acid phosphatise, napthol-AS-BI-phosphohydrolase. Bacteria were also positive for α-glucosidase and N-acetyl ß-glucosaminidase. Heat inactivated ECP was positive only for acid phosphatase and Napthol-AS-BI-phosphohydrolase.

Water quality monitoring for bacterial load

Regular monitoring of water and sediment in marine cage farm at Karwar revealed variations in the total *Vibrio* loads at three different depths in different areas of cage site. Total bacterial counts varied between 1.2×10^4 to 1.8×10^8 cfu /ml. Bacterial loads in the sediment were found to be very high at cage site & ranged between 0.8×10^5 to 4.1×10^8 cfu/g. A positive correlation was also observed between temperature and the total bacterial count and total *Vibrio* count of water at cage site.

Development of Health monitoring protocols

Health monitoring protocols has been developed in RAS and in the brood stock bank to prevent *Amyloodinium* and other protozoan and metazoan infestations. Disinfection and sterilization of the fish culture tanks and associated materials have also been standardized.

Development of molecular diagnostic tools

RNA2 coat protein gene was isolated from VNN infected open sea cage reared seabass.

The gene was used for producing recombinant RNA2 protein using prokaryotic expression system. This can be purified and used for production of subunit vaccine.

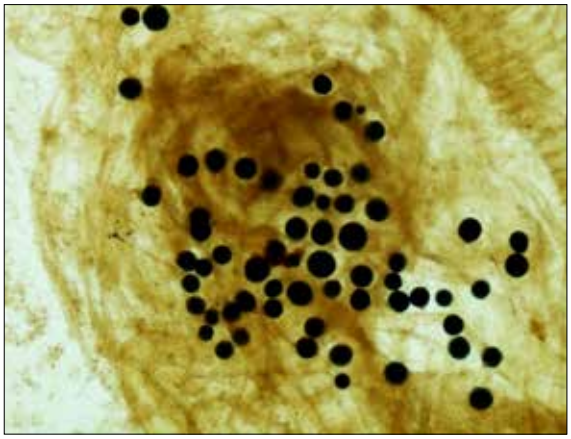
Three different DNA vaccine constructs were prepared using *Vibrio* antigen genes isolated from virulent strains of *Vibrio alginolyticus*, *V. anguillarum* and *V. harveyi*., namely :- Outer Membrane protein (OMPK), Glyceraldehyde 3–phosphate dehydrogenase (GAPDH) and Flagellin

The DNA vaccine construct has to be evaluated for its immunogenicity, efficacy and safety.

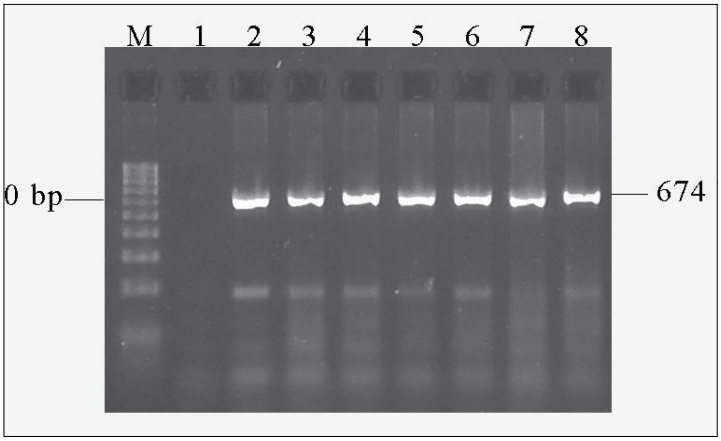
Aquatic animal disease surveillance

Research project: EF-14/NFDB

Under the National Surveillance Programme for Aquatic Animal Diseases (NSPAAD), regular screening of farmed bivalves (*Crassostrea madrasensis* and *Perna viridis*) for OIE listed pathogens was carried out in selected districts of Ernakulam, Malappuram, Calicut, Kannur and Kasaragod. Base line data/ information from the farmers along with the GPS locations of the farms were also collected in the prescribed format. Regular screening of wild bivalves for OIE listed pathogens was carried out along the east and west coasts of India including Lakshadweep islands. Infections with the OIE listed pathogens,



Hypnospores of *Perkinsus olseni* in *P. viridis*



Agarose gel image showing the specific PCR product for *Perkinsus* in *P. viridis*

Bonamia spp. and *Perkinsus* spp. were observed in some of the samples using molecular diagnostics. Epidemiology of *Perkinsus* was studied and so far, 16 species of bivalves were found infected with *Perkinsus* sp.

Disease investigations were carried out on cases of mass mortalities reported from bivalve farms at Ori, Kasaragode, and wild population of short neck clams at Sal river, Velim, Goa. *Perna viridis* collected from mussel farm at Ori, Kasaragode and Sal estuary, Goa indicated infections with *Perkinsus* sp. *Sequencing* and *phylogenetic* analysis of the samples revealed it to be *Perkinsus olseni*, an OIE listed pathogen. Infection with *Perkinsus beihaiensis* was reported from *Saccostrea cucullata* from Goa. No OIE listed pathogens were isolated from the clam populations at Goa where mortality was reported.

Severe WSSV infection was diagnosed in marine cage cultured lobsters at Tharuvaikulam, Tuticorin. All the samples yielded positive results for WSSV in both primary and nested PCRs implying a high load of the virus in the samples.

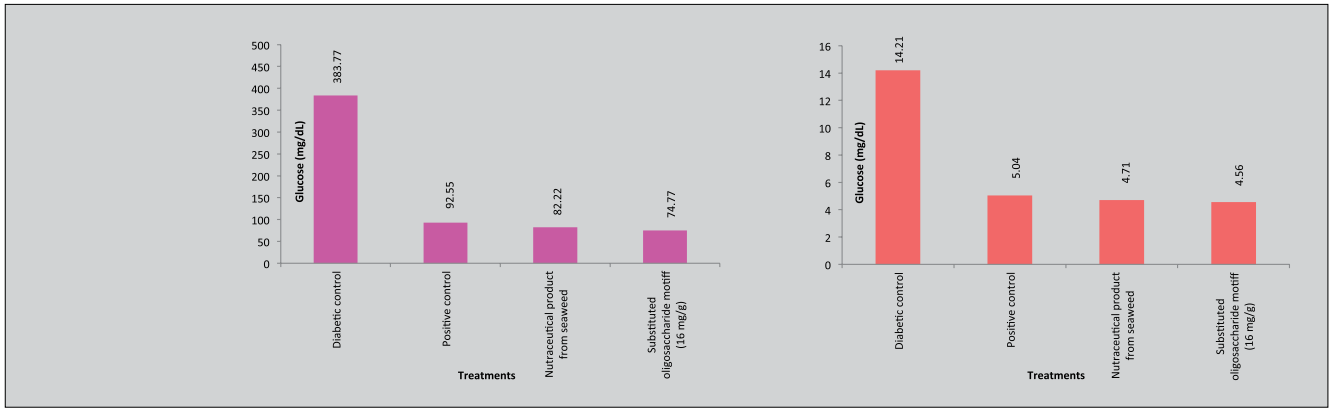
Marine bioprospecting

Antidiabetic nutraceutical product from seaweeds

Research project: FISHCMFRISIL201202600026

A nutraceutical product is developed with activity against type-II diabetes from a blend of marine macroalgae. The product developed from seaweed was compared with that of standard drugs after administering the animals with streptozotocin (a diabetes inducer). The diabetic control had glucose level recorded at greater than 380 mg/dL, whereas the blood glucose levels maintained at about 74 mg/dL (at 65 mg/kg body weight), when the animals were administered with the active ingredients (used at 1:1 oligosaccharide motiffs). The HbA1c levels maintained at about 4.6% (the normal range being 4.3-6.3%) after administering the animals with the same.

In vitro antidiabetic experiments showed that the active principles effectively inhibited (dipeptylpeptidase –IV) DPP-IV, tyrosine phosphatase, amylase, and α-glucosidase. The DPP-IV and tyrosine phosphatase inhibitory activity of the formulation were found to be greater than 72 and 63%, respectively at 100 µg/ml, whereas the antidiabetic principles inhibited other marker enzymes depicting type-II diabetes such as α–amylase (68.59 ±0.31% as compared to that of acarbose 35.75 ±0.49% at 100 ug/ml) and α-glucosidase (67.71 ±0.49% as compared to the positive control 74.7 ±0.45% at 1 mg/ml).



Glucose levels (mg/dl) of the diabetic induced animals treated with the nutraceutical product from seaweeds vis-a-viz diabetic control (STZ induced) and positive control (Gilbenclide)

HbA1c levels (%) of the diabetic induced animals treated with the nutraceutical product from seaweeds vis-a-viz diabetic control (STZ induced) and positive control (Gilbenclide)

The ability of the antidiabetic formulation to significantly inhibit the inflammatory biocatalysts that are responsible to induce type-II diabetes in a secondary metabolic pathway, such as cycloxygenase-II and 5-lipoxygenase were found to be 88.68±0.48 and 89.34±0.56%, respectively than positive control (52-54%). The *in vitro* 2,2-diphenyl-1-picrylhydrazyl (DPPH) and 2,2'-azino-bis 3-ethylbenzothiazoline-6-sulphonic acid (ABTS) inhibitory activities were greater (96.74 ±0.39% and 98.19 ±0.32%, respectively, 1 mg/ml) than positive control (95.72 ±0.5% and 96.44 ±0.42%, respectively). These results demonstrated the potential of the formulation to effectively inhibit the mediators, which are responsible to induce type-II diabetes through various metabolic pathways.

Systematic studies on toxicity and especially pharmacological action were conducted, which showed no toxicity related significant changes in renal or hepatic function, hematological indices and serum biochemical parameters in the treated Wistar rats. No histopathological alterations were observed in the vital organs of treated rats. LD_{50} and sub-chronic No Observed Adverse Effect Levels (NOAEL) for this concentrate were found to be > 5000 mg/kg and 2000 mg/kg BW, respectively. The oral toxicity of this nutraceutical formulation can be classified in category 5 according to the Globally Harmonized Classification System of Organisation for Economic Co-operation and Development (OECD). The results demonstrate a lack of test substance-related general organ or systemic toxicity following oral administration of nutraceutical formulation at a dose as high as 2000 mg/kg/d in the acute toxicity study.

Large scale extraction of the active principles from the raw material was optimized in a factory unit. The total yield of the active principles from the raw material in the factory unit was found to be greater than 20%, which

demonstrated the commercial feasibility of the nutraceutical product. The nutraceutical product is ready for commercialial out-licensing.

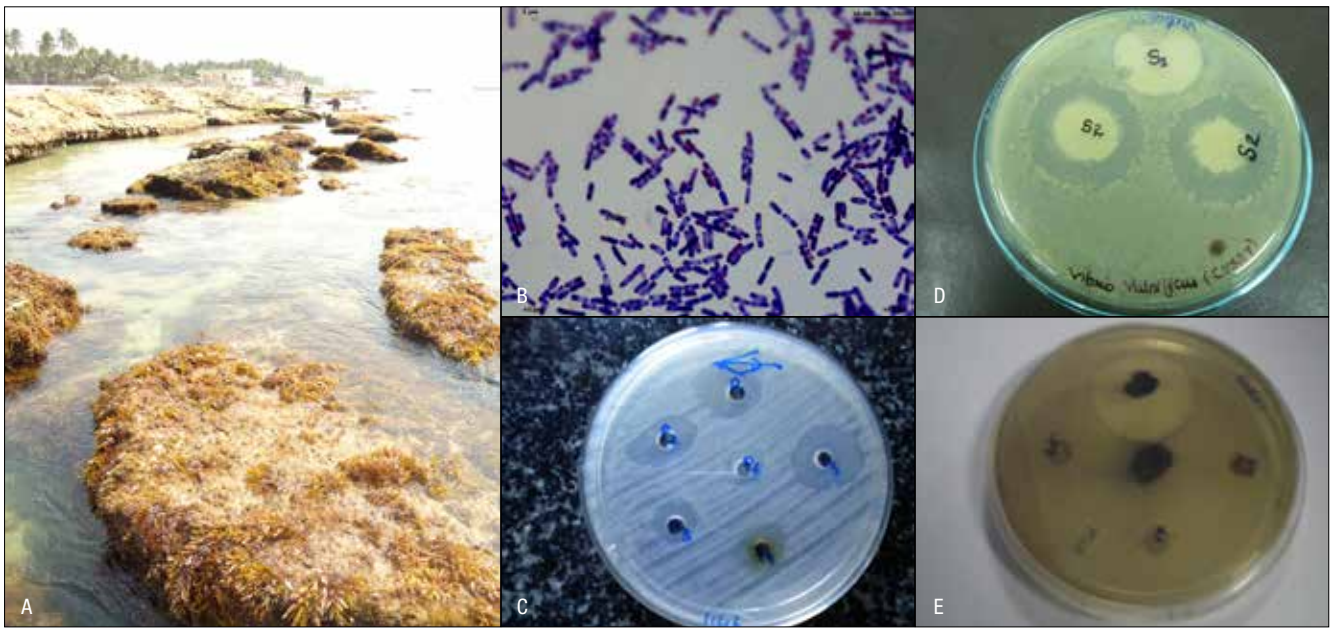
Antioxidant activities and phenolic contents of red seaweeds

Research project: EF-23/ICAR-Platform

Solvent extract of *H. musciformis* and J. rubens showed significantly higher (P <0.05) DPPH· scavenging activities (15.4 & 17.7 %, respectively) than *H. valentiae* (7.7 %). The present study demonstrated that the solvent fractions of *Hypnea* spp may contain compounds having polyphenolic group/s with multiple -OH groups and/or center of unsaturation in their structural moieties to enable them to donate a proton to DPPH radical thereby neutralizing the latter. This study indicated the potential use of red seaweeds, in particular, *H. musciformis* as candidate species to be used as food supplement for increasing the shelf-life of food products, and combating carcinogenesis and inflammatory diseases.

Isolation, structural characterisation and antibacterial activity of compounds from seaweed associated Bacteria

Seaweed associated heterotrophic bacterial communities were screened to isolate potentially useful antimicrobial strains, which were shortlisted and phylogenetically analyzed. Bioactivity-guided isolation of polyene antibiotic 7-O-methyl-5'-hydroxy-3'-heptenoate-macrolactin from *Bacillus subtilis* MTCC10403 associated with seaweed *Anthophycus longifolius* using mass spectrometry and extensive 2D-NMR studies was carried out. The newly isolated macrolactin compound is a bactericidal antibiotic with broad spectrum activity against human opportunistic clinical pathogens. The biosynthetic pathway of 7-O-methyl-5'-hydroxy-3'-heptenoate-macrolactin by means of a stepwise, decarboxylative condensation pathway established



A. Seaweeds at harvest location, B. *Bacillus subtilis* MTCC10403 (SWI2), C. Well diffusion of culture SWI2 supernatant against *V. vulnificus* MTCC 1145; Spot over lawn assay of culture SWI2 against, D. *V. parahaemolyticus* ATCC® 17802™, E. *V. parahaemolyticus* MTCC 451.

the biosynthesis of the parent macrolactin and the side chain 5-hydroxyhept-3-enoate moiety attached to the macrolactin ring system at C-7.

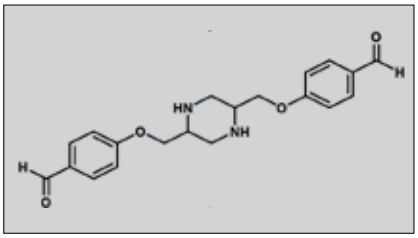
Characterization of antioxidative substances of red Seaweeds *Jania rubens* and *Kappaphycus alvarezii* from the south-eastern coast of the India

Research project: EF-22/DST

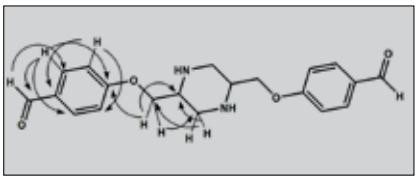
Antioxidant activities of various solvent extracts of seaweeds, *Jania rubens* and *Kappaphycus alvarezii,* the rhodophytan marine macroalgae with significance as a food ingredient, were evaluated using *in vitro* tests. Radical scavenging guided chromatographic separation of the solvent extract of the seaweeds yielded methoxy-4b-methyl-vinyl-dodecahydrophenanthrenol (1) from *Jania rubens*; whilst *K. alvarezii* yielded methyl 2-ethyl-9-oxo-vinyl-octahydro-1-heptalenecarboxylate (2) and ethyl-hexahydro-6-vinyl-10aH-heptaleno[1,10-bc]furan-2,10-dione (3) as major constituents. The DPPH scavenging activity of 1 was greater (91.41%, 0.1 mg/ml) than that of gallic acid (90.56%, 0.1 mg/ml), and therefore, may have potential as a natural antioxidant in the food industry. The H-donation to stabilize the free radicals, as in phenolic antioxidants, is the mode of action of 1, due to the presence of octahydronaphthalen-2-ol.

Anti-Inflammatory concentrate enriched with substituted oligofucans derived from brown seaweed *Turbinaria conoides* (J. Agardh) Kützing

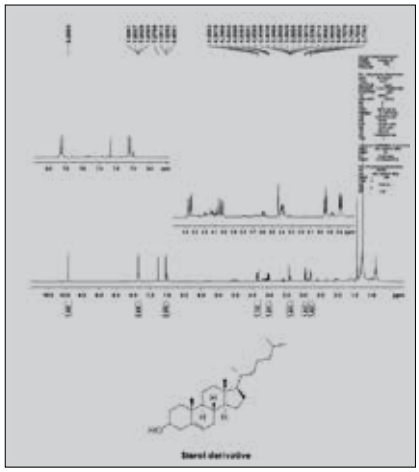
Aqueous extract of the seaweed, *Turbinaria conoides* was purified to obtain an oligofucan enriched seaweed concentrate (OESC). Oligofucans isolated were characterized as two types with (→1)-fucose-(2, 3-diSO_3-)- and (→1)-fucose-(3-SO_3-)-(1→4)-fucose-(2-SO_3-)-(1→4)-fucose-(3-SO_3-)-motifs.



HMBC spectrum of piparazine derivative



1H-NMR spectrum of piparazine derivative



A high DPPH radical scavenging activity was observed for OESC (83.2 %, d0) which showed similar value even at d60 (80.8 %, $p > 0.05$). The substituted polysaccharide possessed significantly higher COX-2 inhibitory activity (67.2 %) than the standard NSAID, aspirin (50.0 %) ($p > 0.05$). The seaweed concentrate and aspirin possessed similar inhibition against 5-LOX enzymes (95.2 and 91 %, $p > 0.05$). COX-2 and 5-LOX inhibitory activities did not vary ($p > 0.05$) even at d30 of accelerated shelf life study. The animals

challenged with substituted polysaccharide motiffs significantly mitigated the carrageenan-induced inflammation in rats at 0.5, 1 and 2 h with 59.7, 73.6 and 70.3 % inhibition, respectively ($P < 0.05$). However, the percent inhibition of paw edema by the standard NSAID, aspirin during 0.5, 1 and 2 h were 51.8, 60 and 68.5%, respectively.

Isolation and characterization of antioxidative bioactives from *Pteroeides esperi* (sea pen) and *Suberites ficus* (Sea orange sponge)

Research project: EF-21/MoES

The solvent extracts of *Pteroeides esperi* (sea pen) were prepared and thereafter purified by repeated chromatography to yield piparazine derivative, 3-omega fatty acid and sterol derivative from *Pteroeides esperi*. The detailed structural analyses of the compounds were carried out by spectroscopicanalyses including 2D-NMR experiments.

Sterol derivative

Xyloccensin types of compounds have been purified from sea orange sponge, and are being characterized in detail.

Cooking and pressing technique for obtaining high quality oil from *Sardinella longiceps*

Research project: EF-19/DST

Conventional Bligh and Dyer method of extracting oil from the edible tissues of *Sardinella longiceps* was compared with different eco-friendly methodologies. Among the different methods studied, cooking followed by pressing showed a beneficial effect on the quality of the oil as evidenced by the lesser saponification (209.8 mg KOH/g), peroxide (11.88 meqO_2/kg), *para-anisidine* (16.2), total oxidation (39.96) and TBARS (6.18 MDAEQ/kg) values.

A comparable lipid yield (8.3 %) with that of Bligh and Dyer method was attained through cooking and pressing method. The greater induction time (0.13 h) indicated the better oxidative stability of cooked and pressed oil as compared to the oil obtained using other methods. The fish oil obtained by cooking followed by pressing has been demonstrated to yield comparable amounts of eicosapentaenoic acid, docosahexaenoic acid, and total polyunsaturated fatty acid contents when compared to the Bligh and Dyer method.

Concentration of *n*-3 polyunsaturated fatty acids form sardine oil and their stabilization

The *n*-3 polyunsaturated fatty acids (PUFAs) from the refined oil derived from *Sardinella longiceps* were concentrated by low-temperature crystallization and urea complexation. The total content of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) was recorded as 29.3 % with greater than 50 % recovery after the process of low-temperature crystallization (4^0C) using the solvent mixture acetone: ethyl acetate (7:3). Further concentration of the *n*-3 PUFAs by means of urea complexation by using the urea-to fatty acid ratio 4:1 at 4 ^{0}C for 12 h contact time yielded 34.5 % fatty acid with a total content of 61 % EPA and DHA.

BROODSTOCK DEVELOPMENT AND SEED PRODUCTION

Broodstock development of high value marine finfishes

Research project: FISHCMFRISIL201202400024

Cobia *Rachycentron canadum*

Cobia broodstock development is being undertaken in the Recirculation Aquaculture System (RAS) under photothermal regime at the Mandapam Regional Centre of CMFRI. Body weight of brooders range from 13.5 – 16.0 kg. Fishes are fed with low value fishes, squid and crab meat @ 2 – 3% of body weight. Broodfishes are regularly monitored for health and gonadal maturity is assessed periodically by cannulation.

Subadults of cobia are also being maintained in sea cages (6 m dia) at the Mandapam Regional Centre for raising broodstock. About 65 fishes maintained in cages are fed twice daily with fresh feed (trash fishes, squid and crab meat) @ 3 – 5 % of body weight. Routine monitoring of gonadal maturity, growth and health parameters are being undertaken.

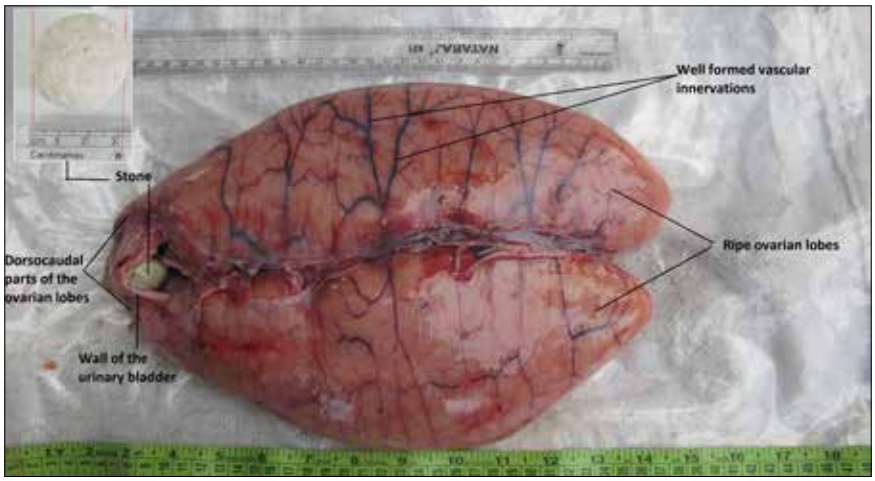
RAS for maintaining cobia broodstock

View of RAS tank with egg collection chamber

Cobia broodstock fishes maintained in cages at Mandapam RC

Spawning failure in female cobia brooder due to urinary bladder stone

Autopsy of hormone injected female cobia, succumbed due to spawning failure revealed presence of large cystic calculus in the urinary bladder. It was found that pressing of the bladder stone against oviduct led to spawning failure. Detailed investigation of the bladder stone was done by electron microscopy.



Position of urinary calculus inside the urinary bladder. Inset: External morphology and size of the stone

Silver pompano *Trachinotus blochii*

Broodstock development of silver pompano under photothermal regulation is being carried out in FRP tanks of 10 t capacity at Mandapam Regional Centre.

FRP tank with photoperiod control

Titanium heater installed in the tank

Pompano brooders in the ratio of 1 female : 3 males under photoperiod regime of 14 L: 10 D are being maintained in each tank. Titanium heater is installed in the tanks for thermal regulation. Periodical cannulation is done to assess gonadal maturity stages. Fishes are fed once daily @ 5% of body weight with fresh squid, crab and shrimp meat mixed with mineral and vitamin pre-mix.

Feeding of pompano broodstock in sea cage

Indian pompano stocked in sea cage for broodstock development

Broodstock of silver pompano is also being raised in cages installed in the sea at Mandapam Regional Centre. A total of 300 nos. of pompano sub-adults in the size range of 1.0 – 1.2 kg are being maintained in a sea cage of 6 m dia. Fishes are fed with low value fishes, squid and crab meat @ 3 – 5% of body weight with regular monitoring of growth and health parameters.

Silver pompano (150 nos.) brought from Mandapam Regional Centre are being reared in pond at the Calicut Research Centre of CMFRI to raise broodstock for breeding programmes.

Indian pompano *Trachinotus mookalee*

Sixty eight numbers of Indian pompano *Trachinotus mookalee* weighing 1.0-6.0 kg collected during February to April 2014 are stocked in sea cage for broodstock development at Visakhapatnam Regional Centre. Fishes are fed twice a day @ 5% body weight with squid and sardine fortified with vitamin E as well as vitamin-mineral mix. Maturity stages of female broodstock are assessed every fortnight by intraovarian biopsy (IOB) and individual development history of fishes are being maintained. Maturity of male fishes are checked by cannulation and also by stripping.

Orange spotted grouper *Epinephelus coioides*

Eighty numbers of *Epinephelus coioides* weighing 1.5 to 3 kg, collected during October to December 2014 were stocked in sea cages at Visakhapatnam. Out of this, 20 fishes weighing 2 -3 kg were stocked in 125 t capacity tanks equipped with recirculation facility having rapid sand filter, protein skimmer and biological filter. Out of twenty, 10 fishes were implanted with 17 α -methyl testosterone (17 α-MT) in combination with letrozole, an aromatase inhibitor. Fishes are fed twice a day *ad libitum*, on squid fortified with vitamins E, A, B complex as well as vitamin-mineral mix. Maturity stages of female broodstock are examined every month by intraovarian biopsy (IOB) and individual history of fishes are maintained. Females implanted with hormone were sex-reversed, which became freely oozing males after two months of implantation.

Broodstock tank (125 t) with re-circulation facility

Broodstock of orange spotted grouper in RAS

Mangrove red snapper *Lutjanus argentimaculatus*

Broodstock development of *L. argentimaculatus* is being undertaken in open sea cages at Kochi, Karwar and Mandapam Centres of CMFRI. Cannulation of broodfishes is being carried out at periodic intervals to assess gonadal maturity. Gonadosomatic index (GSI) and the peak reproductive activity exhibited two peaks (September - October; February - March) in a year. Broodfishes reared in circular cages of 6 m dia are tagged with 12.8 mm PIT tag for identification and monitoring the developmental stages of each fish. Fishes are fed twice daily on low value fishes, squid and mussel meat @ 5%

Broodstock of *L. argentimaculatus* reared in open sea cage at Kochi

Cannulation of broodfishes of *L. argentimaculatus*

body weight. Vitamin and mineral supplements are also given twice a week. Cannulation of brooders at Kochi showed that most of the fishes are males, and females had developed gonads with an ova size ranging from 200 to 400 µm.

A total of 150 nos. of red snappers having an average size of 2 kg weight is being developed to broodstock in pens at Calicut Research Centre. Development of snapper broodstock in coastal earthen pond, lined with silpaulin is also being attempted at Calicut and these fishes have attained an average weight of 3 kg.

John's snapper *Lutjanus johnii*

Broodstock of *Lutjanus johnii* collected from Uppunda are being maintained in marine cage farm of Karwar Research Centre. Fishes are fed twice daily with squid and shrimp mixed with cod liver oil and multivitamin @5% of body weight.

Grey mullet *Mugil cephalus*

Forty two number of grey mullets weighing 600 g to 2 kg are being reared in cages to develop broodstock for breeding programmes in open water at Pooyappilly, Kochi

Breeding and seed production of high value marine finfishes

Cobia *Rachycentron canadum*

Six spawning inductions by hormonal manipulation were undertaken in cobia at Mandapam Regional Centre. From 5 successful spawnings, 4.29 million fertile eggs were obtained with an average fertilization rate of 73%. Eggs hatched out with an average hatching rate of 60% and 4.88 lakhs larvae were used for fingerling production.

Factors influencing survival and metamorphosis of cobia larvae

Larviculture of cobia were conducted in 2 t rectangular FRP tanks (yellow coloured) employing green water technique by adding microalgal culture *Nannochloropsis*

oculata at a cell density of $1x10^6$ cells ml^{-1}. Mean larval density of 5 nos. l^{-1} and a mean rotifer density of 25 nos. ml^{-1} up to 12 days post-hatch (dph) and early grading daily from 8 dph onwards gave maximum survival rate of 9.5% and the shortest metamorphosis duration of 23 to 25 dph at ambient temperature (27.5 - 29.5ºC) and light (2100-2800 lux). When larvae were reared at a higher light intensity (2700-3900 lux) keeping all other factors at optimum level, mean survival rate increased to 10% and the metamorphosis period came down 20 to 22 dph. Results of the study can be applied to commercial hatcheries for increasing survival and reducing the metamorphosis period.

Silver pompano *Trachinotus blochii*

Sixteen spawning inductions of silver pompano were attempted at Mandapam Regional Centre and fertile eggs were obtained in fourteen induction experiments. The eggs were hatched and larviculture experiments were undertaken for fingerling production.

Details of spawning and fertilization rate of *Trachinotus blochii* at Mandapam Regional Centre

Date of experiment	No. of eggs (lakhs)	Fertilization rate (%)	Hatching rate (%)	No. of larvae used for fingerling production (lakhs)
03-05-2014	1.62	83.6	66.5	0.90
09-05-2014	1.55	90.0	85	1.20
09-06-2014	1.23	72.5	77.7	0.69
12-07-2014	3.24	38.2	50.9	0.63
24-07-2014	3.88	39.8	88.3	1.37
16-08-2014	2.29	83.6	77.5	1.48
26-08-2014	2.03	73.3	48.7	0.72
19-09-2014	2.30	36.9	82.3	0.70
30-09-2014	2.91	63.6	63.5	1.17
22-10-2014	2.08	78.3	54.4	0.88
07-11-2014	1.25	67.6	62.10	0.52
24-11-2014	1.75	87.0	0.00	0.00
12-12-2014	1.20	83.0	88.00	0.88
11-01-2015	0.94	55.0	57.7	0.30
14-02-2015	3.05	95.8	93.5	2.71
20-03-2015	0.25	Un fertilized	0.0	0.00

Off season spawning of silver pompano by photothermal regulation

First successful off season spawning of silver pompano was achieved in FRP tanks maintained under constant photothermal regime. Breeding experiments were conducted in 2 nos. of 10 t capacity FRP tanks under photothermal manipulation. Pompano brooders (females having average weight of 1.52 kg and males weighing 1.3 kg) were maintained in the tanks by regulating the temperature and photoperiod. Intra-ovarian cannulation revealed maturation of ova at the altered temperature and photoperiod. Hormonal induction with GnRH led to successful spawning consecutively for three cycles. Fertilized eggs were collected and stocked in the incubation tanks for hatching. Present success can pave way for successful spawning and seed production of silver pompano all through the year.

Sampling of pompano broodstock

Parameters influencing survival and metamorphosis in larviculture of silver pompano

Impact of larval density, live feed density, light and temperature was evaluated on the survival and metamorphosis of silver pompano larvae. Mean survival rate of 33.9% and shortest metamorphosis duration of 24 to 25 dph at ambient temperature (27.5-29.5ºC) and light (2100-2800 lux) was obtained with larval density of 10 nos. l^{-1} and mean rotifer density of 25 nos. m l^{-1} up to 28 dph. With a higher light intensity of 2700 -3900 lux, mean survival rate increased to 35% and the metamorphosis period reduced to 22 to 23 dph.

Hatchery produced Indian pompano fingerling

Indian pompano *Trachinotus mookalee*

Spawning induction and successful larval rearing of the Indian pompano *Trachinotus mookalee* was carried out at Visakhapatnam Regional Centre. Larvae of *T. mookalee* were reared by feeding with suitable live feed followed by artificial pellet feeds and they attained weight of 38-40 g on 92 dph.

Orange spotted grouper *Epinephelus coioides*

Four induced breeding experiments of *E. coioides* were undertaken at the Visakhapatnam Regional Centre. Spawning inductions were performed in hapa undertaken to cage. Four trials were attempted to rear the larvae in green water system with supplementaion of different live feeds.

Larvae of *E. coioides* in larval rearing tank at 10 dph

Shellfish seed production

Brooders of the spiny lobsters *Panulirus ornatus* and *Panulirus homarus* as well as the slipper lobster *Scyllarides tridacnophaga* have been developed at Chennai Research Centre. Larval rearing trials of the blue swimmer crab *Portunus pelagicus* are also in progress at Chennai Research Centre.

New modified rearing strategies with pretreated aged seawater were attempted to hold and feed sand lobster phyllosoma. Larval rearing experiments were carried out using estuarine jellyfishes, *Acromitus flagellatus* and *Crambionella stuhlmanni* as phyllosomal feed. Newly hatched phyllosomal stages showed instant reception and continuous feeding for more than 6 h. Phyllosoma of sand lobster accepted artificial diets prepared in the micro-bound form having 2-3 mm dia and B cells formation was observed in hepatopancreas indicating positive assimilation. This is the first time an artificial diet prepared for lobster larvae has shown acceptance under our lab conditions.

Distribution of high value marine finfish fingerlings for farming

Cobia

A total of 3620 fingerlings of cobia were produced during the period and were supplied to farmers, fishermen, entrepreneurs, government organisations and researchers.

Silver pompano

A total of 230980 fingerlings of silver pompano were produced during 2014-15 and supplied to farmers, fishermen, entrepreneurs as well as research and development organisations.

Optimum conditions for packing and transportation of cobia and silver pompano fingerlings

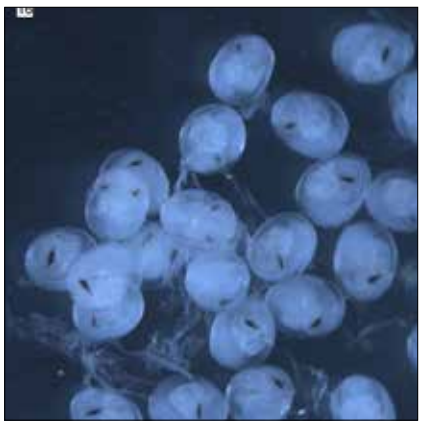
Optimal packing density of fingerlings according to size (length and weight), duration of starvation, distance of transport, water volume, water temperature and oxygen level in the transportation bags were standardised.

Cobia fingerlings having mean length of 75.0 ± 13.5 mm and mean weight of 5.0 ± 1.2 g, were transported for 24 h duration at 20 - 22°C at a stocking density of 2.5 fingerlings per litre with 100% survival. Pompano fingerlings with a mean length of 30.59 ± 0.24 mm and 2.00 ± 0.04 g weight were transported for 24 h duration at 20- 22°C at a stocking density of 5 fingerlings per litre with cent percent survival. Experiments on bulk transportation of pompano fingerlings in 1000 litres capacity tanks holding 600 litres of water with continuous aeration from oxygen cylinders fitted in a truck revealed that pompano fingerlings having mean length of 30.59 ± 0.24 mm length and mean weight of 2.00 ± 0.04 g can be transported for 36 h duration at 20- 22°C at a stocking density of 10 fingerlings per litre with 100% survival.

Marine ornamentals

Broodstock development and successful spawning of *Stenopus hispidus* (coral shrimp/banded cleaner shrimp)

Six pairs of *S. hispidus* were collected from Lakshadweep Island, transported to Marine Hatchery at CMFRI, Kochi and were reared in 150 l glass aquaria with biological filtration, provided with shells and small rocks to imitate natural reef habitat. Brooders were fed with mussel and shrimp meat up to satiation. First spawning obtained after rearing for 3 months under captive conditions and three pairs were mated. Eggs were oval in shape having 0.62 to 0.67



Microscopic view of eggs of *S. hispidus* on 13th day of incubation

71 day old *S. hispidus*

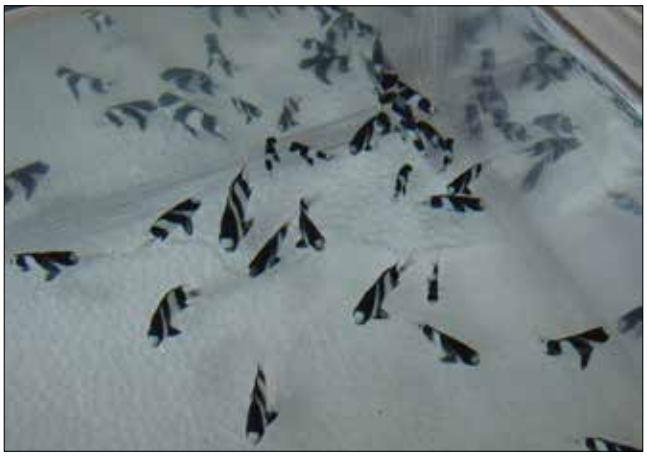
Female *S. hispidus* carrying eggs under abdomen

mm dia and of 0.79 to 0.84 mm length. When the eggs were about to hatch, colour turned creamy white and eye spots appeared four to five days before hatching. Larvae were kept in 500 l aquaria at an initial density of 10 larvae l^{-1} and were fed with different combinations of live feed. Various developmental stages were documented and standardisation of larval rearing is in progress.

Marine ornamental fish

In the marine hatchery at CMFRI Kochi, broodstock development and breeding of the ornamental fishes *viz., Amphiprion ocellaris, Amphiprion percula, Amphiprion clarkii, Amphiprion frenatus, Premnas biaculeatus, Pseudochromis dilectus* and *Nemateleotris decora* were successfully carried out. Other ornamental fishes like batfish, gobiids and dottybacks are also being undertaken. Five pairs of broodstock of *A. frenatus* and one pair of *A. clarkii* were developed within 60 days from the hatchery produced juveniles. Effect of duration of photoperiod on survival of larvae and juveniles of *A. frenatus* were studied.

At Mandapam Regional Centre, broodstock development and seed production of commercially important marine ornamental fishes namely *Pseudanthias squamipinnis, A. percula, A. ocellaris, Dascyllus aruanus, Chrysiptera cyanae* and *Amphiprion perideraion* (pink skunk clown) are under way. Further, scaling up of seed production of *A. percula* and pink skunk clown was carried out.



Dascyllus aruanus

Chrysiptera cyanae

Amphiprion percula

Pseudanthias squamipinnis

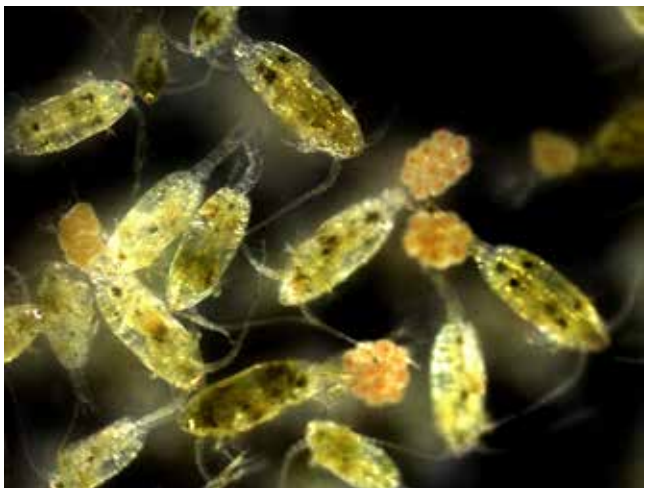
Live feed culture

Marine microalgae culture

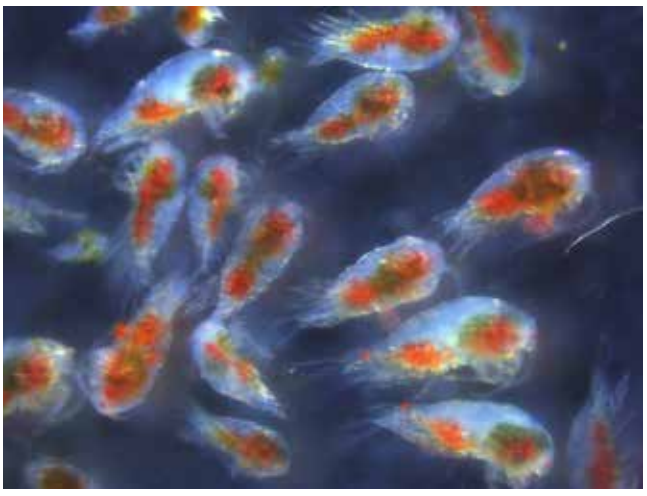
Pure strain cultures of the microalgae, *Nannochloropsis* sp., *Isochrysis* sp., *Chaetoceros* sp., *Thalassiocera* sp., *Tetraselmis* sp., *Skeletonema* sp., *Dunaliella* sp., *Chlorella* sp., *Platonomas* sp. and *Pavlova* sp. were maintained with high cell densities in the laboratories at CMFRI Kochi as well as at Karwar, Tuticorin and Visakhapatnam Research Centres of CMFRI. Pure strains are supplied to various commercial shellfish and finfish hatcheries as start-up cultures and used in various live feed and larval rearing studies.

Culture of copepods

At Vizhinjam Research Centre of CMFRI, mass production protocol for the calanoid copepod *Temora turbinata* was standardised. Regular harvest on alternate days up to 5-8 million naupliar stages is possible from continuous culture tanks of 500 l capacity without affecting the population. Mass culture techniques for culture of another species *Pseudodiaptomus serricaudatus* was also developed and weekly harvest of 13-14 million naupliar stages is possible from continuous culture tanks of 500 l capacity.



Pseudodiaptomus serricaudatus



Temora turbinata

Experimental studies revealed 70% more larval survival of *Hippocampus kuda* fed with a combination of copepods *T. turbinata* and *P. serricaudatus* as compared to traditional artemia/rotifer feeding. Larvae fed on copepods showed faster growth and brighter colouration.

At CMFRI, Kochi three species of copepods (*Pseudodiaptomus serricaudatus, Pseudodiaptomus annandalei* and *Euterpina acutifrons*) were isolated and maintained as pure cultures. Mass culture of these species has been achieved up to 5 t.

Tuticorin Research Centre, calanoid copepods *Acartia spinicauda, Temora turbinata, Pseudodiaptomus serricaudatus* and cyclopoids *Oithona rigida* are being cultured in 3 scales *viz.*, stock culture, intermediate culture and mass culture. At Karwar Research Centre cyclopoid copepod cultures are maintained in indoor as well as outdoor conditions at a density of 50 nos. ml^{-1}.

Rotifer culture trials using *Nannochloropsis* paste

Experiments were conducted at the Visakhapatnam Regional Centre for preparing microalgal paste from *Nannochloropsis* sp. for use in offseason rotifer production. Results revealed that chilling of *Nannochloropsis* paste with 10% glycerol as preservative, yielded good viability of the cells which can be successfully used for rotifer culture. However, rotifer production using *Nannochloropsis* paste deep frozen with 20% glycerol gave better results.

GROW-OUT TECHNOLOGIES

Innovations in sea cage farming and coastal mariculture

Research Project: FISHCMFRISIL201202500025

Cage farming of cobia, seabass and pompano has been carried out along the east and west coasts during the period 2014 -15.

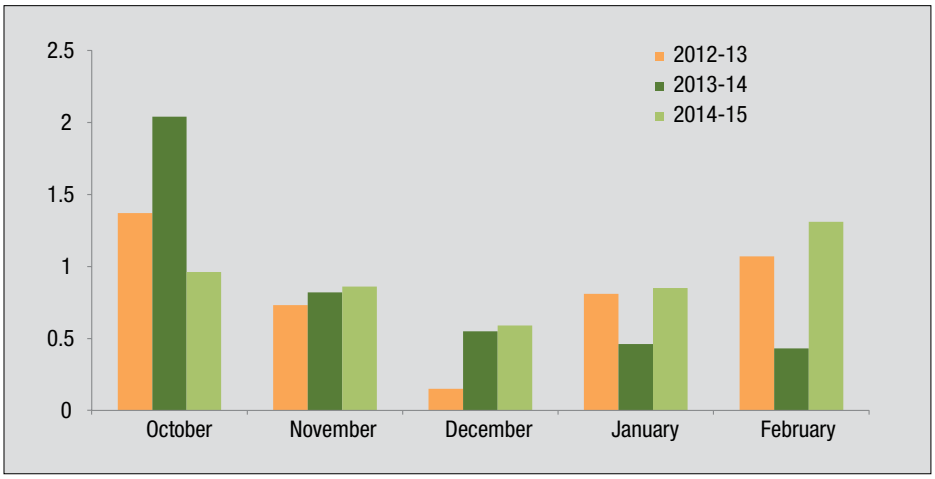
Karwar: Cage culture of Asian seabass, cobia and pompano was carried out during 2014 -15 in the marine farm of Karwar Research Centre. Cobia fingerlings were stocked in two 6 m dia. steel cages at a stocking density of 4 individuals / m^3. The fish were fed with oil sardine and pellet feed @ 8 % and 6 % biomass. The average weight of cobia fed with oil sardine was 0.75 kg, whereas, the weight of cobia fed with pellet feed was 350 g at 150 days of culture. Average weight of seabass at 300 days of culture was 2 kg and pompano attained an average weight of 300 g. Weight gain of cobia at 150 DOC fed with oil sardine and pellet feed were 4.8 g / day and 2.14 g / day respectively. The weight gain of cobia cultured at Marine farm of Karwar was low during the winter season in all the three years (2012-13, 2013-14 & 2014-15 whereas the weight gain was more during summer months.

Cage farm at Karwar

Cage culture of cobia at karwar

Asian seabass (*Lates calcarifer*)

Harvest cobia at Karwar



Weight gain of Cobia cultured in 6 m dia cages at Karwar (2012-13, 2013-14 & 2014-15)

Cage culture was also taken up as a part of participatory programme by involving the Self Help Groups of fishermen at Polem, Nuem and Talpona in Goa. Cage culture operations were undertaken in Talpona (19 cages), Polem (10 cages) and Nuem (13 cages) of Goa under the supervision of Karwar Research centre during the report period.

Seabass and cobia with initial weights of 15 g and 30 g respectively are stocked in 6 m dia. cages @ 14 nos / m^3 and 4 nos / m^3respectively. The average weights of cobia, pompano and seabass at 150 days of culture were 700 g, 250 g and 300 g at Talpona, whereas in Polem, the weights of cobia and Seabass at 150 days of culture were 800 g and 280 g respectively. At Nuem, the average weight of cobia and seabass at 120 days of culture were 400 g and 250 g respectively. Weight gain of cobia was 4.5, 5.14 and 3.08 g / day respectively at Talpona, Polem and Nuem. A total production of 6 tonnes, 4 tonnes and 3 tonnes of asian seabass, cobia and pompano, with a farm gate price of Rs. 400/-, Rs. 350 and Rs. 350 respectively was recorded by Self Help Group of fishermen under cage farming at Goa.

Environmental monitoring in cage and reference sites

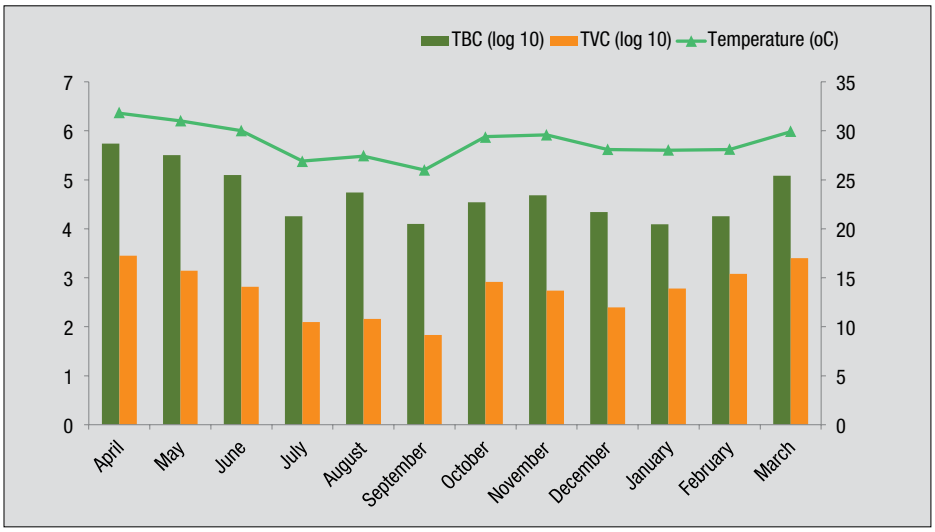
Water and sediment quality was analysed during the report period and the study revealed variation in the salinity values in different depths of the cage site and reference site. The temperature recorded in the surface waters ranged between 26.2°C and 29°C; whereas the salinity of surface waters varied from 16 ppt to 32 ppt. The Dissolved oxygen levels reached a minimum level of 4.9 ppm and the maximum was 7.2. The pH varied between 7.5 and 8.2. Ammonia levels ranged between 0.02 and 0.12 ppm. Nitrate and nitrite levels are in permissible levels at cage and reference site.

A significant difference was observed in the values of salinity and dissolved oxygen levels of surface, column and bottom waters of cage site. There is no significant difference in the water quality parameters of cage and reference site.

Biodiversity studies in cage sites

Monthly samples of water and sediment were collected from inside and outside the cages for the analysis of microbial studies. The study revealed total bacterial loads of water ranged between 1.2 x $10^4$and 1.8 x 10^8cfu/ml and the sediment bacterial loads varied between 0.8 x $10^5$and 4.1 x 10^8cfu/g. A significant variation was observed between the microbial loads of water at different depths and the loads also varied between species. Variation was also found between the bacterial loads of sediment at cage and reference sites.

Biodiversity studies near the cage site revealed that Ambassis sp. and Modilolus sp. are the most dominant species at cage site. Plankton diversity of cage farm site represented Copepods, Amphipods, Chaetoceros, Coscinodiscus, Biddulphia, Plaktonella, Sagitta, Amphipods, Rhizosolinia, Oikopleura, Nitszia, Pseudonitszia and Thalasionima. Fouling studies in marine farm revealed barnacles, oysters, green mussel and polychaete worms are the most commonly encountered fouling on cage frames and nets.



Total Bacterial and Total *Vibrio* loads (log values) of water in relation to water temperature (°C) at cage site (2014-15)

Mandapam: Five hundred hatchery produced cobia fingerlings were stocked in a circular GI metal cage of 7 m diameter and 3.5 m depth floated at Mandapam Sea. The initial length and weight of the fingerlings ranged from 12.1 to 18.5 cm and 16 to 23.7 g respectively. The fishes were fed with trash fish once in a day @ 5 % body weight. Monthly samplings were carried out and the growth performance was recorded. After about 8 months of farming the harvested fishes ranged in total length from 71 to 102 cm and in weight from 4.1 to 6.9 kg. The farm gate price was Rs.310 per kg.

Cobia harvested from cage at mandapam

Cobia Fisherman Welfare Association, a self-help group from Rameswaram took up sea cage farming with the technical support of Mandapam Regional Centre of CMFRI. Ten GI cages of 6m diameter and 3.5m depth were fabricated and floated by them. A total of 6400 fingerlings of hatchery produced cobia were supplied by the Mandapam Regional Centre. The length of the fish harvested after 8 months of farming ranged from 48 to 62 cm and weight from 1.0 to 2.3 kg. The farm gate price was Rs.270 / kg. The total harvest from the cage culture operations was about 9 tonnes.

Visakhapatnam: Culture of grouper, *Epinephelus coioides* was undertaken in sea cages and and reported average weight of fish was 1.014 kg. after one year.

Seabass culture with different stocking densities was carried out and recorded more growth in low stocking density (15 m^{-3}) with final weight of 690.7±41.3g after 5 months of culture.

Six galvanized iron (GI) cages measuring 6 m in diameter and 4 m in depth were installed using pole mooring, in Rajulalanka, Narsapuram in the West Godavari district of Andhra Pradesh. The cages were stocked with 7200 seabass fingerlings ranging in size from 15 to 30 g and 4000 mullet wild fry weighing 2 to 3 g collected from the wild. About 2.4 lakh hatchery reared PL/11 of *Litopenaeus vannamei* was also stocked. The stocked seabass grew well and reached an average weight of 649 g and after five months of grow-out.

Kochi: Culture of wild collected snappers undertaken in 6 x 6 m dia cages and recorded 1.0-1.4 kg size of fish after 8 months of culture. In Chellam, 1000 numbers of snapper seed was collected and stocked in **r**ectangular cages 1.5 mx1m with a stocking density of 250 nos / cage. The culture is under progress. Culture of lobsters in 2 x 2 x 3.5 m cages with initial weight of 50 g was done by feeding with green mussel and recorded a final weight of 300-350 g at the time of harvest.

Vizhinjam: Farming trials were initiated in a participatory mode with a farmer's group from Thirumullavaram and stocked wild collected lobsters (*Panulirus homarus*) in the cage with a stocking density of 125nos/m^3. Average weight at the time of stocking was 72.4g (45-102) and reached up to 109.4g (65-160) in four months period.

Chennai: Asian seabass culture was undertaken by Association of Kovalam Progressive Fishermen (AKPF) fisher youth of Kovalam with the technical support of Chennai Research Centre and reported 600 kg fish biomass at the time of harvest The harvested sizes ranged between 0.44 to 1.1 kg, with an average size of 0.5 kg. An innovation in marketing was tested for the first time. The cultured fish was sold live to a recreational sport fishing agency in Chennai @ Rs 400/- per kg.

Veraval: lobster culture in marine cages was undertaken for 90 days with different stocking sizes and observed that the growth rate was significantly higher in lower size group compared to the higher size groups.

Tuticorin: Lobster culture trial with high stocking density ((85 - 90 nos / m^3) in low cost wooden net-cages at Manapad sea, Tamil nadu and fed with cuttle fish waste and low value fishes once daily @ 5-8 % body weight. The culture period was 120-150 days and Partial harvest was done for every 25-30 days (100 gm and above) with a market price of Rs. 1200 - 1800 per kg.

Mumbai: Feeding experiments were conducted involving the fishermen community at cage farm in Malwan in Sindhudurg district. Feeding experiments were done by using the commercial floating fish feed with protein contents of 38%, 40% and 43% during the monsoon period and the fishes weighed 250-300g with 50% survival. The experiment is under progress.

Coastal Mariculture

Mandapam: Regional Centre conducted demonstration programmes in Andhra Pradesh on culture of pompano in ponds. About 65,000 numbers of silver pompano fingerlings measuring an average length of 3.0 cm with

an average weight of 2.0 grams were stocked in 2 batches during June and July 2014. Approximately, 15,000 fingerlings were stocked in each pond, measuring one hectare size. All the four ponds are located in Gokula Lanka village near Yanam in East Godavari District of Andhra Pradesh. The fishes are being fed with extruded floating pellet feed having crude protein of 45% and crude fat of 10%, manufactured by M/s. Growell Feeds, Krishna District, Andhra Pradesh. The fishes are fed three times a day between 5 - 10% of their body weight. After rearing for a period of 8 months the fishes in the two ponds which were stocked in first batch have attained an average length of 27.30 ± 3.62 cm and average weight of 375.32 ± 8.07 grams. The second batch of fishes have attained an average length of 22.65 ± 2.90 cm and average weight of 258.31 ± 5.76 grams.

Pompano culture pond

Farm grown Pompano

Calicut: Red Snappers juveniles of size of 100 gm were collected from the wild and 250 numbers stocked in a 200sq.m pond. The fishes attained the weight of 1 Kg. for a period of 7 months fed with thrash fish (3 % of body weight of cultured fish). Survival rate is 100 %. A total of 245 Kg. of Red Snapper was harvested and it was sold Rs. 400/- per Kg. The total Input cost was Rs. 35,000/- and net income of Rs.63,000/- was realised. Culture of Pompano was also undertaken by private farmers in pond at Atholi and stocked with 5000 numbers of pompano and the culture is under progress.

Veraval: Pond farming of silver pompano *Trachinotus blochii* was carried out in hypersaline shrimp ponds (47-75 ppt) during winter period at Kodinar. One thousand fishes were stocked and were fed with formulated feeds. After 120 days of culture the survival rate was 93% with a growth rate of 0.26g/day.

Brackish water farming:

Kochi: Farming of Asian seabass, cobia and pompano were undertaken as a part of participatory programme in cages at various location at Kochi. Four thousand numbers of *Lates calcarifer* measuring 4-5 cm procured from RGCA was nursery reared in hapa for 45 days and stocked in three 4 x4 x 3 m steel cages installed in backwater at Panampukad. The fish were fed with low value fish at the rate of 5% body weight. After a period of one year the fish had attained 700 g to 1.8 kg and was harvested and sold at a farm gate prize of 500-600 Rs/kg. Three cages produced a total of 4 tonnes of fish with low stocking (800nos/ cage-one tonne; 850 nos/cage- one tonne; 1650 nos/ cage; 2 tonnes production).

Fiji Minister vising the cage farm at Kochi

cages at Kochi

Fiji Minister vising the cage farm at Kochi

The milkfish, *Chanos chanos* was successfully farmed in a 4 m x4 m steel cage in brackishwater at Panampukad, Kochi. About 4500 seed of 4 cm size procured from Rameswaram area in Tamil Nadu were stocked during April 2014 and was fed on formulated feed and after a period of 8 months the fish were harvested and 500 kg fish were caught with an average weight of 400 g. The farm gate prize was Rs.200/kg. The growth was better in cage than in pond, may be due to the better feeding practices in cage.

A 6 m diameter HDPE cage installed in the open waters at Pooyappilly during 2010 is continually stocked this year also with mullet and pearl spot. A fishermen group of three families was the beneficiary. The cage was stocked with 1500 numbers of pearl spot *Etroplus suratensis*. The 10 g fish had attained 150-250 g weight in eight months of culture. More farmers are coming forward for the technology to be adopted in the area.

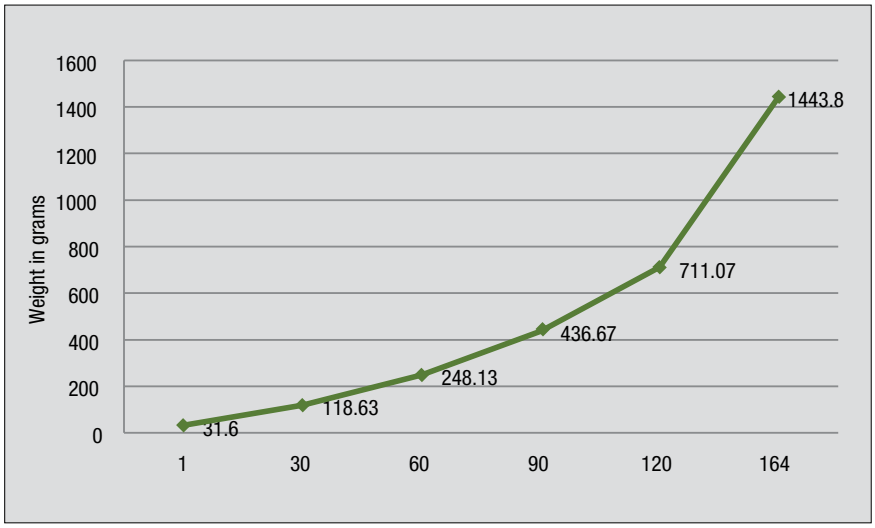
A galvanized Iron cage measuring 6 x 6 m size was installed in the open backwater of Poothotta in Ernakulam district at a depth of about 8 m with good water exchange and was stocked in April 2014 with locally collected Etroplus seeds and hatchery produced seeds of GIFT tilapia procured from Matsyafed hatchery, Veliyamgodu, Malappuram District. . Etroplus seeds stocked showed good growth in this area and has grown to a size of 250 to 350 g weight in 4 - 6 months were harvested with a survival rate of 85 %. The tilapia attained a size of 750 ± 65 g weight and 23 ± 5 cm length with a period of 8 months and survival was 88 %.

Cage harvest at Poothota backwaters

During the months of November to December large number of carangid juveniles were caught in the Chinese dip nets along puthenvelikara area and these juveniles carangids were further farmed to marketable size with the participation of fishermen groups. Fishes collected in Chinese dip nets. Fishes were reared in small cages made of HDPE nets of 1 x 2x 2 m and circular net cages of 6 m diameter. The seeds based on their sizes were sorted and stocked in different nets for farming as well the growth studies. Seeds were fed with low value fishes caught in the dipnet as bycatches. Fishes are growing well and growth is monitoring.

Growth of cobia in brackish water environment was studied using square cage of size 4X4x3m floated is at brackish water areas of Perumon, Kollam. Juveniles of *R.canadum* of mean length & wt 19.2 cm &1.66g respectively were procured from CMFRI hatchery at Mandapam and stocked at a density of 4.0nos./m^3. The salinity at the farming site during the start of farming was 25 ppt. Feeding was done with trash fishes, *ad libitum*, collected from the local fishermen. After 3 months of rearing, commercially available was given to the fishes by replacing 50% of the trash fishes. Fishes were harvested after a culture period of 164 days. During this period fishes were grown to a size range of 1200 - 2220g (mean length: 49.4cm) with a survival rate of 82%. The harvested fishes were marketed locally at an average price of Rs.350/ kg. During the culture period the due to the monsoon rains, salinity at culture

site was dropped to 5 ppt in some occasions, but did not affect the growth and survival of the fishes in cages.



Growth of cobia reared in brackishwater cages

The growth observed is comparable to that obtained elsewhere for cobia in marine cages and indicates that cobia farming can be taken up in brackishwater also. Between September/October and April/May months eight months is ideal for farming cobia in brackishwater areas of Kerala.

About 8000 numbers of seeds of silver pompano were brought from the Mandapam hatchery and stocked in a 1 ha area tide fed culture pond at Tripunithura. The water temperature ranged from 28-30°C, salinity 7-15ppt, pH 7.8-7.96 and O_2 5 - 6.26 mg/l Fishes are fed with combined diet of clam meat and pellet feed two times a day and grown to a size of 200g after 4 months. Culture is continuing with participation of the farmer.

Mangalore: Integration of mussel farming with small scale finfish cage culture (IMTA) in Alvaekodi, Udupi was undertaken and reported an increase in production from 1.1 t to 11 ton during the period. Expansion of cage farming was made to Mulky area in Dakshina Kannda, with suitable modifications in cage designs to suit the location.

Chennai: A low scale cage culture cycle was attempted by fishermen youth Cuddalore Chinnakuppam by stocking 114 numbers of Asian sea bass in community rearing with limited numbers of black pomfrets, Indian halibut, Lutjanids and Therapons (wild caught seeds) in an indigenous cage suspended in the estuarine-bar mouth zone. After 125 days of culture, 45 kg of sea bass was harvested and sold as live game fish. The value realized was Rs 18,750/-.

Integrated Multi Trophic Aquaculture (IMTA)

Integrated Multi trophic aquaculture (IMTA) is the practice which combines in appropriate proportions the cultivation of fed aquaculture species (E.g. fin fish / shrimp) with organic extractive aquaculture species (e.g. shell / herbivorous fish) and inorganic extractive aquaculture species (e.g. seaweed) to create balanced systems for environmental stability (bio-mitigation) economic stability (product diversification and risk reduction) and social acceptability

harvested seaweed and cobia from IMTA

Integrated farming of Kappaphycus with cages at Veraval

(better management practices), is getting importance at global level.

The scientists of Regional Centre of Central Marine Fisheries Research Institute (CMFRI) took initiative to impart the concept of integrated type of farming to the fishermen group of Munaikadu village who are already practicing commercial level seaweed farming. The centre has given three numbers of low cost cages of size 4.5 m× 4.5 m× 3.5 m and stocked with cobia fingerlings at the rate of 100 numbers per cage. The seed material (720 kg) for the seaweed was also supplied for integrating with the cages. The cages were stocked with cobia fingerlings of size (20 cm length and 50 g average weight) during the first week of April 2014. A total of 12 numbers of seaweed rafts (12× 12 feet) at the rate of 60 kg of seaweed per raft were integrated with the cobia cages during second week of September 2014. The daily feeding of the fishes with low value fishes, maintenance of cages and the required watch and ward were done entirely by the fishermen group. The harvest was made on 30th October 2014. A total of 652 kg of cobia was harvested. The length ranged from 59 to 83 cm and weight ranged from 1.8 to 4.2 kg (average weight 3.25 kg). The farm gate price of cobia realized was Rs.210 per kg. The total seaweed harvested was 2,700 kg wet weight. The seaweed harvested was used as seeding material for the next crop. It was observed that the seaweed rafts integrated with cobia cages had a better average yield of 225 kg per raft in contrast to 150 kg per raft of others which were not integrated.

At Verval integration of Seaweed *Kappaphycus alvarazi* along with lobster cages was experimented. Net tube method used for the grow out culture of seaweeds in open sea. It is noticed that at lower temperatures the growth was poor for *K. alvarazi* during the winter months.

BIVALVE FARMING

Research Project: FISHCMFRISIL201201400014

The farmed bivalve production increased marginally by 9% to 14,085 t during 2013. The oyster production increased by 12% and mussel by 8%. Mussels formed 67 % of the production. Mussel farming is constrained due to lack of adequate seeds, quality of seeds and issues of environmental overcapacity in the main farming area

In Malabar area the mussel production was estimated to be 9272 t from the Kudumbashree sponsored SHG as well as the individual mussel farmers.

Kasargod district contributes about 59% of the total production followed by Kannur (23%), Kozhikode (12%) and Malappuram (6%).

In Karnataka, the farmed bivalve production in the State increased by 4-fold from 7.5 t in 2013 to 29 t during 2014.With technical guidance of CMFRI, 29 farmers ventured into mussel farming of *Perna viridis* by rack & rope method in Udupi district. About 7,245 numbers of seeded grow-out ropes of 0.75 to 1 m length suspended from the farm structure in November 2013, yielded 4 kg of green mussel/rope by 2014. The gross revenue realised was Rs. 18.79 lakhs.

For oyster farming, the following spat collectors were placed near the oyster beds in the Mulki estuary during September 2014.

- Split bamboo of 3x1.5 m dimension were fabricated using and fixed at 0.9 m above the bottom substratum.
- Oyster rens suspended from rack fabricated near oyster beds.
- Lime coated tiles were suspended from rack fabricated near oyster beds.

Crassostrea madrasensis spat settlement was observed on all spat collectors. Rock oyster (*Saccostrea cucullata*) spat settlement was observed on oyster rens during November-December 2014. The rock-oyster spat settled on oyster shell ren attained a size ranging from 2 to 3 cm by February 2015.

For green mussel spat collection, settlers made of coir mat of 1m x 1m were fabricated and deployed off Someshwara by long line from October 2014 onwards. Spat settlement was observed on coir mats with size range of 2.9 to 4.6 mm during January 2015.

Coir mat spat settlers for green mussel

Bio-accumulation of bacteria in oysters from shellfish growing waters in Ashtamudi Lake

Ashtamudi Lake is the second largest brackish water lake in Kerala and supports approximately 12,000 tonnes of bivalve fisheries per year. Oysters are one of the most important edible bivalve molluscs commercially exploited from the lake. Oysters are filter-feeding animals that can filter large volumes of water for food and thus concentrate a microbial load more than tenfold in growing environments. Oysters and oyster growing waters were sampled over a one-year period from July 2012 to June 2013 for analysis of total coliforms (TC), faecal coliforms (FC), *E. coli*, faecal *Streptococci* and total plate counts (TPC). *E. coli* MPN values in oyster growing waters were below the threshold limits set by the USFDA and EU during the months of December, January, February, March and April. Seasonally, the highest MPN values for *E. coli* were obtained during the monsoon season, and this trend gradually decreased during the post-monsoon and pre-monsoon periods. The rate of bio-accumulation of *E. coli* significantly correlated ($p < 0.01$) with faecal coliform content in the water, which in turn showed significant ($p < 0.01$) seasonal variations. Similarly, *E. coli* displayed a significant ($p < 0.01$) variation in accumulation during different seasons. A strong negative correlation ($R^2 = -0.70$, $p < 0.05$) between temperature and *E. coli* numbers in oysters was observed, while rainfall and *E. coli* were positively correlated ($R^2 = 0.695$, $p < 0.05$). Correlations between salinity, pH and faecal coliforms were not significant ($p > 0.05$).

Seasonal changes in bio-accumulation factor (BAF) in *C. madrasensis* oysters in Ashtamudi Lake

Month	BAF			
	FC	E. coli	FS	TPC
July	1.45	2.18	6.25	1.36
August	3.79	2.84	9.5	1.34
September	3.79	5.84	3.0	2.61
October	6.66	1.90	1.0	9.10
November	1.50	1.44	0.93	1.22
December	5.86	4.41	7.0	24.78
January	2.60	7.85	1.75	4.28
February	68.35	17.72	1.30	2.37
March	10.0	5.35	2.50	2.66
April	9.89	9.72	4.25	5.17
May	6.66	1.0	3.75	2.50
June	7.50	2.25	3.16	12.86

MABE PEARL OYSTER

Building up of stock of pearl oysters for image pearl production studies.

More than 47,000 spat were produced in the hatchery at Vizhinjam and same is reared to produce 35,000 juvenile oysters of*P. fucata* for image pearl production trials. As requested by the Department of Fisheries, Government of Kerala (DOF), a five day training programme on image pearl production was jointly organized by Vizhinjam Research Centre of CMFRI and Department of Fisheries, Kerala from 4-8 August, Fifteen participants nominated by the

department of Fisheries were trained on various aspects of marine image pearl production during the training.

Carrying capacity of estuaries for mussel farming

Environmental parameters and productivity of the ecosystem was studied to estimate the carrying capacity of Mulki Estuary for mussel farming. The carrying capacity was estimated considering the daily food ration and filtration rate of mussel (per hour). The estuary has an area of 113,081 Sq.M. The carrying capacity was estimated to be 159.7 t of mussels which is equivalent to 53 racks or 18,641 seeded ropes of one meter length.

Farming area (m^2)	Tidal volume (m^3)	Food supply (g POM in farm)	Food demand/kg mussel (gPOM/ day)	Carrying Capacity (tonnes mussel)	No. of seeded ropes (1m length)
113,081	108,973	548,496	3.15	159.7	18,641

POM - Particulate Organic Matter

Extension activities on mussel farming

The practical dissemination of bivalve farming technologies in the coastal belts in Malabar coasts in Kadalundy areas of Vallikkunnu panchayat in Malappuram district by training 62 women fisher folk with the Community Development Scheme (CDS) of the panchayat by mobilising 11 SHGs of women of 60 members through CDS of the panchayat with loan amount worth Rs 1,25,000/- and subsidy of Rs 50,000/- for mussel culture in Kadalundy estuaries.

The assessment of the dynamics of SHGs with standardized protocols developed and in consultation with NGOs and State Government department and developedGDEI: Group Dynamics Effectiveness Index

Commercial viability of black pearl production in the Andamans and conservation mariculture of ETP gastropods

Research project: EF1-MoES

During the year, comparative studies were made on growth and survival of the hatchery raised blacklip pearl oyster spat, *Pinctada margaritifera* of the same cohort in different stocking densities, depths and weaning methods in open sea farming. Initially, all spat were showed high growth rate irrespective of their stocking densities and weaning depths. Small spat (runts) showed steep shoot in growth during the initial days while comparing with normal spat stocked in low densities. This potency of sudden spurt in growth is directly depend on the size of the spat getting transplanted and it is found to be reduced when the size of the spat increases. The IGR values for runts were much higher than that of the normal spat weaned in different densities (SD-10, 20 and 30). No mortality of spat was noticed in low stocking density (SD - 10) during entire period of experiment (210 days).

The growth and survival rates were decreased with increasing DOC and stocking densities. But both are not influenced by the depth of the culture zone. The highest cumulative mortality (52 %) was observed in the high density stocks (runts) maintained in surface floating barrels. However, the mortality rate was low (15-18%) during initial days (summer months) and then drastically increased to 36-45% by the onset of monsoon. Spats weaned on spat settlers with protective webbing showed high size variations with

50% cumulative mortalities without regular defouling and cleaning. Complete mortality was observed within 100 DOC in settlers without protective webbing due to high predatory pressure. Temperature considered as one of the main environmental variable influenced the spat growth. The growth and mortality was also influenced by the intensity of rainfall and the water currents along with total suspended sediment in the culture site. Results indicate that the growing area and its environment variability strongly influence the growth than their genetic factors.

Tribal Sub Plan

Farming activities under Tribal Sub Plan

Veraval: 'Sidi' tribals of veraval were trained in sea cage farming including integration of seaweeds with cage farming. Spiny lobster *Panulirus polyphagus* seeds collected from single day trawlers were stocked in *13* GI cages having net cage size of 4m dia and 3m depth.The stocking density maintained was 300 number of lobsters per 4m diameter cages with 3m depth. Average growth rate of lobsters estimated is 0.95g/day during the culture period. The beneficiaries were trained in improved sea water free method of transportation of lobster seeds from distant areas.

Chennai: Programs on edible oyster farming were initiated at Oyyalikuppam

Collection of Lobster seed at Veraval

village, VayalurPanchayat, Kancheepuram district. Training was imparted to the tribal women and young men on the collection of edible rock oyster spat/seed from the adjoining estuarine water bodies, cleaning and sorting. The stocking racks were fabricated by them with our guidance. Ten box type racks were prepared and stocked with oyster seed at the selected site with necessary water quality for the farm, each holding nearly 300 oyster seed and suspended in the water column by casuarina poles and ropes. The culture has been going on since six months. So far the oysters have shown good growth performance. A serviced small FRP dingy was provided to the people for the transport of materials and daily monitoring works at the site. They have been constantly briefed about the changes in the water quality and turbidity and water currents. All the necessary net, iron frame materials, ropes, casuarinaspoles, bags, chisel, hammer, green mesh, air tube, aerators, scoop nets, and filter materials have been provided through

the program. Depuration facility has been developed with FRP tanks and cement tanks fabricated and assembled in a small sheltered cemented and temporary roofed area in the village. The tribals are also being trained on ornamental fish holding and rearing in smaller tanks and are attending to broodstock maintenance of some fish varieties.

Cages under Tribal Sub-Plan project , Dahanu, Maharashtra

Mumbai: Tribal groups of Bharadkhol in Raigad district &Dahanu in Palghar district have been trained for open sea cage culture. The technology developed by the institute has been transferred successfully under TSP-Scheme. Four 6-m diameter GI cages, 2 each at Dahanu& Palghar have been successfully deployed and stocked with spiny lobster *Panuliruspolyphagus.*In addition, two 3-m diameter GI cages have been deployed at Arnala, Dist. Palghar for lobster seed collection.

Kochi: Eight families of Ullala community at Nettur of Ernakulam District were identified as beneficiaries for this programme as an alternative livelihood option. Two 4x 4m GI cages were deployed in nettor backwaters and cages were stocked with pearl spot, Scatophagus and mullets. A total of 500 fishes of various species were stocked. The group members were trained in various aspects of cage management like feeding, cleaning of nets and exchange of nets etc. the day to today management of cages like feeding the fishes three times a day, periodical cleaning and watch and ward are being done by the group members. The farming of fishes in this cage is progressing as per schedule.

Mangalore: Under TSP programme, 3 racks were installed in Mulky Estuary, Dakshina Kannada District for culture of bivalves (mussels and oysters). Efforts are being taken for the collection of oyster spat by suspending the rens in the estuary. Small scale estuarine cages in Mulky Estuary, Dakshina Kannada District were installed for finfish culture. Four cages of 6 x 2 x 2 m were made for the stocking of the fingerlings. The outer net is netlon material of 50 mm mesh size and the inner net is of 18 mm mesh. The frames are of GI pipes.

MARINE BIODIVERSITY

CORAL REEF ECOSYSTEMS

Research project:FISHCMFRISIL201201600016

Coral diversity, fish assemblage, sponges and other bio-resources associated with coral reefs of Gulf of Kutch and selected islands (Kadamat, Amini, Kavarathi, Chetlat and Kiltan) of the Lakshadweep Archipelago were investigated following the Line Intercept Transect (LIT) and Underwater Visual Census (UWVS) methods.

Gulf of Kutch

Biodiversity survey was carried out on shallow coral reefs in the Gulf of Kutch. Seventy five benthic reef transects were undertaken on the five selected reefs of the Gulf of Kutch. Out of these, two were fringing reefs, *viz.*, Mithapur reef and Laku point, and three were submersible platform reefs.

A total of 31 species of hard corals belonging to 24 genera and 9 families were recorded from the surveyed reefs. Six species of hard corals, *viz., Coscinaraea columna, Montipora turgescens, Paracyathus stokesii, Platygyra pini, Plesiastrea versipora, Turbinaria reniformis* were not recorded previously from any of these islands though they were recorded from other reefs of the Gulf of Kutch. *Turbinaria mesenterina, Goniopora djiboutiensis, Goniopora stokesi, Hydnophora pilosa* are new records from the Gulf of Kutch reefs. Average relative abundance showed that *Porites lutea* formed dominant species on the reefs, *Dipsastrea favus* formed abundant, 16 species formed common, 9 species formed uncommon and two formed rare categories. *Bernardpora stutchburyi* and *Turbinaria reniformis* were the two species recorded as rare.

Highest diversity was found at Laku point (H“= 2.10) which was followed by Savaj Island (H“=1.82) and Mithapur reef (H“=1.78). Of all the LIT stations surveyed, 9th station at Laku point was the most diverse. Average percentage hard coral live cover of the surveyed reefs was 30.87%. The highest value was obtained at Savaj Island (41.9%) and lowest at Goose Island (7.73%). As per the Coral Mortality Index estimated, most of the reefs were healthy except Goose reef which has been categorized as ‘sick’. The Relative Condition Index also gave similar results, classifying goose reef as poor in condition and all others as fair.

Lakshadweep islands

Despite the wealth of information documented by various organizations on the Lakshadweep coral reefs, only few detailed biodiversity assessments of its inshore coral ecosystem have been conducted. An attempt has been made by CMFRI to investigate biodiversity of an oceanic reef system surrounding Kadamat and Amini islands (during February 2014), Kavarathi (January 2015) and Chetlat and Kiltan islands (March, 2015) of the Lakshadweep Archipelago, for geo-referenced resource mapping of the various bio-resources. Coral diversity, coral growth, fish assemblages, microbial diversity, plankters, sponges, echinoderms, molluscs and seaweeds associated with coral reefs were recorded.

Amini and Kadamat Islands: 55 species of hard corals from Amini and 72 from Kadamat islands were recorded. The dominant genera recorded among the hard corals were *Porites* and *Acropora* followed by *Psammacora, Favites, Favia, Leptoria, Pocillopora, Echinopora, Hydnophora* and *Leptastrea*.

Kavarathi Island: 52 species of scleractinian corals under 22 genera and 2 non-scleractinians were recorded. Genus *Acropora* dominated with 13 species, followed by *Porites* (7), *Pocillopora* (5), *Pavona* (3) and *Fungia* (4). The other genera represented were *Psammacora, Stylophora, Montipora, Goniopora, Favia, Goniastrea, Platygyra, Leptoria, Hydnophora, Leptastrea, Cyphastrea, Cycloseris, Echinopora, Merulina, Symphyllia*, and *Turbinaria*. The non-scleractanian corals were represented by the blue coral *Heliopora coerulea* and *Millepora* sp.

Acanthaster planci (crown of thorns star fish)

Occurrence of star fish *Acanthaster planci,* popularly known as the "Crown of thorns" which is a voracious predator on hard corals was also recorded. The sea cushion *Culcita* sp. are corallivores, were also observed in a few sites. Sea surface temperature in Kavarathi ranged from 28.2°C to 30.5°C and the salinity varied from 36 to 37 ppt. The average depth in the lagoon area was 2.1m and in the adjacent open sea, beyond the lagoon, depth was 10 m. The water clarity was excellent in all the stations with the turbidity values ranging from 0.19 ntu to 0.57 ntu.

Gorgonids: Two species of gorgonids, *Annella mollis* (Nutting) (new to Lakhshadweep) and *Melithaea squamata* (Nutting) (new to Indian waters) were also recorded from Kavarathi.

Reef fishes: About 182 species of reef associated fish was recorded from Kavarathi atoll. Family Pomacentridae formed the major group which contributed up to 18% of the total reef fish diversity. This was followed by wrasse family, Labridae (11%), Acanthuridae (7%) and Chaetodontidae.

Phytoplankton and zooplankton: Phytoplankton and zooplankton samples were collected from different stations in the lagoon as well as the open sea beyond the lagoon of Kavarathi Island using standard methods and the collected plankters were quantified.

Phytoplankters of Kavarathi Island were identified up to generic level and a total of 31 genera viz. *Navicula, Rhizosolenia, Ceratium, Pleurosigma, Asterionella, Nitzschia, Coscinodiscus, Leptocylindrus, Melosira, Phormidium, Isthmia, Gyrosigma, Licmophora, Biddulphia, Peridinium, Prorocentrum, Skeletonema, Thalassiosira, Ornithocercus, Synedra, Thalassiothrix, Noctiluca, Hemiaulus, Bacillaria, Planktoneilla, Cerataulina, Pyrophacus, Dinophysis, Chaetoceros, Ceratocorys* and *Amphiosolenia* were recorded.

The displacement volume of zooplankton in the sea was higher when compared to that of lagoon area. The average volume at sea, and lagoon were 5.74 and 0.66 ml per 100 m^3 respectively, which indicate higher productivity in the sea.

An average of 17831 numbers per 100 m^3 was recorded from Kavarathi waters. In the lagoon area, the density of zooplankters was 3676 numbers per 100 m^3 while in the sea it was 24908 numbers per 100 m^3.

A total of 19 groups of zooplankters viz. copepods, ostracods, chaetognaths, medusae, siphonophores, polychaetes, cladocera, mysids, amphipods, doliolids, *Oikopleura* sp., *Lucifer* sp., crab larvae, shrimp larvae, echinoderm larvae, fish eggs, fish larvae and molluscan larvae. Out of the total, a maximum of 53% was contributed by copepods followed by ostracods.

The composition of zooplankters in the lagoon and open sea waters were distinctly different. In the sea, copepods, ostracods, chaetognaths and fish eggs dominated while in lagoon, crab and shrimp larvae formed major share.

An average density of 1002 numbers of zooplankters per m^3 was observed from Kavarathi waters. Out of the 31 genera recorded, *Ceratium* contributed the maximum with 27% followed by *Peridinium* (15%) and *Rhizosolenia* (15%). Other genera contributed only less than 10% in Kavarathi waters including both lagoon and sea.

Molluscan biodiversity: Molluscan resources of Kavarathi Island included mostly gastropods, bivalves and slugs. The gastropods comprised of 10 species representing 6 families. The families represented were Cerithidae, Conidae, Cypraeidae, Muricidae, Strombidae and Turbinellidae. The bivalves comprised of three species representing three families (Carditidae, Tellinidae, Tridacnidae). Three species of sea slugs belonging to two families (Chromodorididae, Phyllidiidae) were also recorded.

Echinoderms: The Spotted Worm Sea cucumber, *Synapta maculata*, Spined Brittle Star, *Ophiothrix purpurea,* Black feather star, *Colobometra perspinosa* and Neck lace star fish, *Fromia monilis*, Star fish, *Acanthaster planci*, Sea star (blue, red), *Linckia laevigata, Linckia multiflora* and black sea cucumber *Holothuria* sp. were also recorded from Kavarathi Island.

Linckia laevigata

Fromia monilis

Synapta maculata

Linckia multiflora

Kavarathi Island: Molluscs

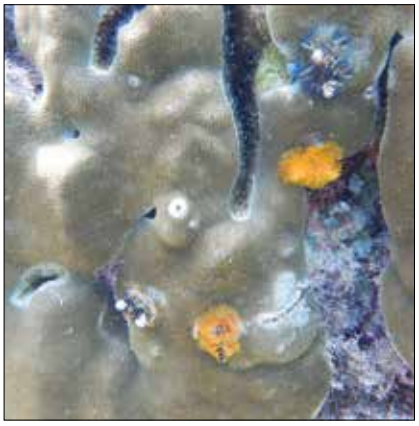
Slugs	
Chromodorididae	*Glossodorius cincta* (Sea slug)
Phyllidiidae	*Phyllidia coelestis* (Sea slug)
Phyllidiidae	*Phyllidiella zeylanica* (Sea slug)
Gastropods	
Buccinidae	*Pollia undosa* (Wavy goblet whelk)
Cerithidae	*Cerithium nodulosum* (Sea snail)
Conidae	*Conus virgo* (Sea snail)
Conidae	*Conus leopardus* (Leopard cone)
Cypraeidae	*Cypraea tigris* (Tiger cowry)
Muricidae	P*urpura panama* (Rudolph's purpura)
Muricidae	*Drupa morum* (Mulberry drupe)
Muricidae	*Drupa ricinus* (Prickly spotted drupe)
Strombidae	*Harpago arthriticus* (Chiragra spider conch)
Strombidae	*Canarium urceus urceus* (Little bear conch)
Turbinellidae	*Vasum turbinellus* (Sea snail)
Bivalves	
Carditidae	*Cardita variegata* (Rectangular false cockle)
Tellinidae	*Tellina scobinata* (Rasp tellin)
Tridacnidae	*Tridacna maxima* (Giant clam)

Coral diseases and bacterial diversity in Kavarathi

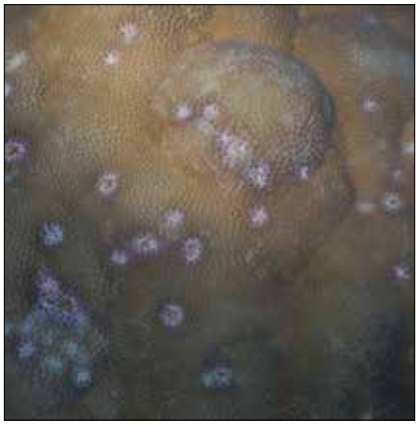
Sporadic coral bleaching/patchy bleaching was observed in *Acropora* spp., *Pocillopora* spp., *Porites* spp. and *Pavona venosa*. Tissue loss due to predation by crown of thorn starfish (*Acanthaster planci*), sea snails, sea urchins and coral reef fishes were encountered. Diseased conditions were found more pronounced in massive corals as compared to branched corals. Disease conditions such as white band disease (in *Acropora* sp.) and white syndrome due to diffuse to focal tissue loss (in *Acropora* spp., *Montipora* spp.,

Bleaching in *Acropora formosa*

Bleaching in *Pavona venosa*



Pink/white line syndrome due to sabellid infestation



Pigmentation response to parasitic infestation

Porites spp. and *Favia* spp.) were observed. Pigmentation response to parasitic infestation (by polychaete tube worms, trematode and cirriped larvae) such as pink spot/line syndrome was found widespread among *Porites* spp. and *Montipora* sp. Microbial investigations were undertaken in healthy and diseased corals. A total of 131 pure bacterial isolates obtained are being subjected to detailed analysis.

Chetlat and Kiltan Islands

Corals: A distinct zonation was noticed in Chetlat with *Acropora* dominating the southern side of the lagoon, the middle part with massive and branching colonies of *Porites* and the northern part with the blue coral *Heliopora coerulea*. Bleaching was not observed in the surveyed areas in Chetlat but in Kiltan bleaching was noticed in some *Acropora* colonies. In Chetlat sea surface temperature ranged from 28.5ºC to 30ºC and the salinity varied from 36 to 37 ppt. The average depth in the lagoon area was 1.15 m and the turbidity values varied from 0.46 ntu to 0. 72 ntu. However, in Kiltan the sea surface temperature varied from 30ºC to 31ºC and salinity values 26- 27 ppt. The turbidity values ranged from 0.44 to 0.69 m at the surveyed sites.

Preliminary investigations on the hard corals at the surveyed areas revealed the presence of 47 species of scleractinian corals under 21 genera in Chetlat and 40 species under 16 genera in the Kiltan island. The non scleractinians were represented by *Heliopora coerulea* and *Millepora* sp. In Chetlat, hard corals were represented by 21 genera. *Acropora* dominating with 10 species. *Porites* with 5 species is the next abundant genera followed by *Pocillopora* (3), *Favia* (3) and *Fungia* (3). The genera *Pavona*, *Platygyra, Montipora, Leptastrea, Goniopora, Lobophyllia* and *Psammacora* have two species each. The other genera represented were *Goniastrea, Leptoria, Hydnophora, Acanthastrea, Cyphastrea, Cycloseris, Echinopora,* and *Euphyllia*. Genus *Acropora* with 9 species dominated in Kiltan followed by *Porites* (5), *Favia* (4), *Pocillopora* (3), *Goniastrea* (2), *Favites* (2), *Pavona* (2), *Psammacora* (2), and *Leptastrea* (2). The other genera represented were *Platygyra, Montipora, Goniopora, Hydnophora, Cyphastrea, Agaricia* and *Leptoria*.

Molluscan resources from Chetlat and Kiltan Islands included mostly gastropods, bivalves and cephalopods.

Chetlat Island: The bivalves comprised of two species representing two

families (*Carditidae, Tellinidae*). The gastropods comprised of 13 species representing 10 families *(Cerithiidae. Conidae, Cypraeidae, Haliotidae, Lucinidae, Muricidae, Neritidae, Strombidae, Trochidae* and *Turbinellidae).* Cephalopod was represented by 1 species.

Kiltan Island: The bivalves comprised of single species representing 1 family (*Carditidae*). The gastropods comprised of 24 species belonging to 10 families (*Cerithiidae , Conidae, Cypraeidae Haminoeidae, Harpidae, Lucinidae, Muricidae, Nassariidae, Strombidae* and *Terebridae*)

Diversity of molluscs in Chetlat island

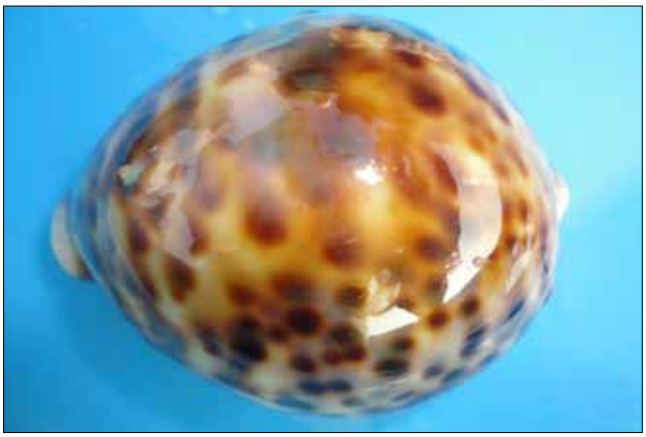
SPECIES	FAMILY
Bivalves	
Cardita variegata	Carditidae
Tellina scobinata	Tellinidae
Gastropods	
Cerithium nodulosum (Giant knobbed clam)	Cerithiidae
Conus ebraeus (Hebrew cone)	Conidae
M*auritia scurra indica* (Indian scurra)	Cypraeidae
C*ypraea caputserpentis*	Cypraeidae
Luria Isabella (Fawn-coloured cowry)	Cypraeidae
Arestorides argus (Hundred-Eyed cowry)	Cypraeidae
Haliotis (Haliotis) *varia* (Common ear shell)	Haliotidae
Codakia punctata	Lucinidae
Drupa lobata (Lobate drupe)	Muricidae
Nerita polita	Neritidae
Gibberulus gibberulus gibberulus (Hump-back conch)	Strombidae
Trochus maculatus	Trochidae
Vasum turbinellus (Horned heavy whelk)	Turbinellidae
Cephalopods	
Octopus cyanea	Octopodidae

Cerithium nodulosum : Chetlat and Kiltan Islands

Conus virgo : Kavaratti Island

Kiltan Island : Molluscs

SPECIES	FAMILY
Bivalve	
Cardita variegata	Carditidae
Gastropods	
Rhinoclavis aspera (Rough creeper)	Cerithiidae
Puncticulis arenatus (Sand-dusted cone)	Conidae
C*onus betulinus* (Beech cone)	Conidae
Conus ebraeus (Hebrew cone)	Conidae
Conus textile (Textile cone)	Conidae
Conus rattus	Conidae
Conus leopardus (Leopard cone)	Conidae
Rhizoconus miles (Soldier cone)	Conidae
Luria isabella (Fawn-coloured cowry)	Cypraeidae
Monetaria caputserpentis (Snake-head cowry)	Cypraeidae
Monetaria moneta (Money cowry)	Cypraeidae
Diniatys dentifer	Haminoeidae
Harpa amouretta	Harpidae
Codakia punctata	Lucinidae
Thais (Thalessa) *virgata* (Chestnut rock shell)	Muricidae
Nassarius papillosus	Nassariidae
Nerita maura	Neritidae
Nerita polita (Polite nerite)	Neritidae
Plicate Nerite	Neritidae
Canarium ochroglottis	Strombidae
Gibberulus gibberulus gibberulus (Hump-back conch)	Strombidae
Canarium mutabile (Changeable conch)	Strombidae
Harpago chiragra (Chiragra spider conch)	Strombidae
Oxymeris maculatus (Spotted auger)	Terebridae



Cypraea tigris : Chetlat Island

Conus leopardus : Chetlat and Kiltan Islands

Soft Coral propagation (GOMBR, Mandapam)

Experiments were conducted on the propagation of soft coral *Lobophytum pauciflorum* at Mandapam. The substrata used for the experiments were concrete blocks, compressed red clay tiles and granite stones. The explants were removed from healthy parent colonies, using a sharp razor blade. The cut areas of the parent colony as well as the explants were found to heal in about 20 to 25 days period. The explants tied on different types of substrata, did not show any variation in the time taken for attachment and the average time taken for attachment was fifteen days. The growth of the newly established colonies (which was taken as maximum spread of the colony) ranged from 15 mm to 48 mm in a culture period of 4 months.

A view of the attachment of the explants to the substratum provided

Colonies of *Lobophytum pauciflorum* developed in the wet laboratory

Experiments were also conducted on the healing time and substrate preference of soft coral *Dampia pocilloporaeformis*. The cut fragments were found to attach on to the substratum in about 14 to 21 days and the time taken for attachment did not vary with the substrates (concrete blocks, floor tiles, compressed red tiles). The cut area of the fragment was found to heal in about 2 weeks time.

ISLAND ECOSYSTEM

Research project:FISHCMFRISIL201400100033

Preliminary survey was carried out during October 2014, off Karwar coast to select an island for biodiversity assessment and valuation. The islands covered were Mogergudda, Devgad island (oyster rock Island), Sanyasguddi (Madlingad),

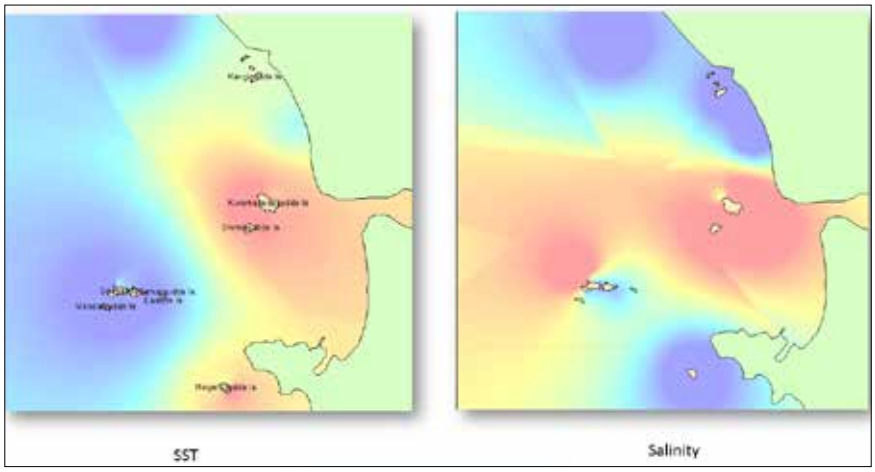
Devagad Island

Kurumagad Island, Baldi Island, Doddakaki, Sannakaki and Bide Island (Goa).

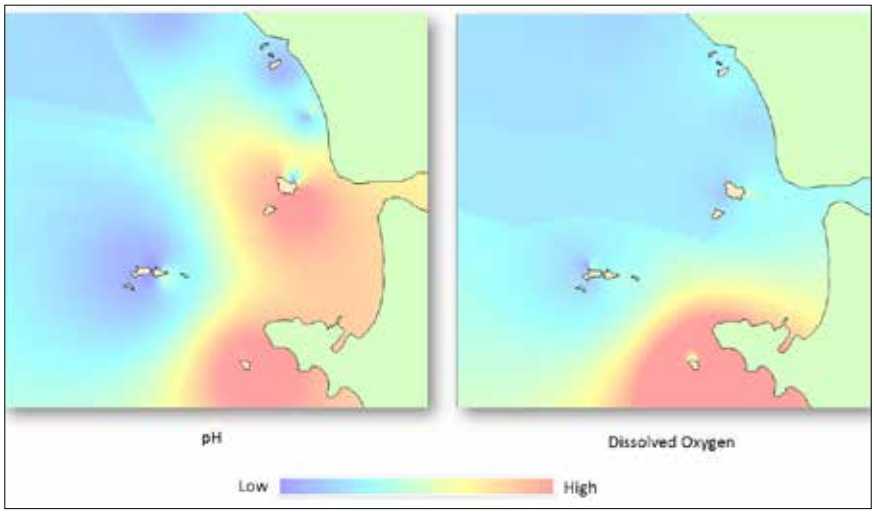
Salient features of the islands surveyed: All the islands were steep rock hills jutting out of the sea. The rocky islands supported benthic fauna on soft and hard substratum. Among the islands there were few pockets of beach and small patches of mangroves. The depth around the islands ranged from 6-16 m. River Kali runs in the vicinity of Kurumagad and Shimis Islands.

Salient features of the Devagad island (Oyster Island)

The Devagad Island was selected for further biodiversity and valuation studies. The Devagad Island is a complex of two islands with small rocky clusters surrounding these. The depth ranged from 9-12 m. There are no inhabitants, but a lighthouse is situated on the island and the staff resides on the island. There is dense vegetation, birds etc. A small patch of mangrove exists on the rear side of the island. Artisanal fishing activity takes place around the island. Biodiversity of this island was studied by underwater diving and mapping the resources through underwater photography and videography.



Spatial variation in Sea surface Temperature (SST) and Surface Salinity



Spatial variation in pH and Dissolved Oxygen

The water quality parameters such as salinity, pH, temperature and depth around 5-6 stations fixed by GPS were recorded. Phytoplankton and Zooplankton samples were also collected. The surface salinity ranged from 28-30 ppt, bottom salinity 28.6 to 29 ppt, pH 8.0 -8.2, dissolved oxygen 8.0-9.8 ml/L, sea surface temperature 29.3 -30.2°C.

Fish diversity

The fish diversity around the Devagad Island was dominated by marine ornamental fishes belonging to Pomacentridae: (Blackspot sergeant, *Abudefduf sordidus;* Bengal sergeant, *Abudefduf bengalensis;* Sergeant major, *Abudefduf vaigiensis;* Brown damoiselle, *Neopomacentrus filamentous;* Yellowtail damsel, *Neopomacentrus nemurus;* Damsel, *Stegastes* sp. and other Pomacentrids); Labridae: (Wrasse, *Halichoeres* spp.) Acanthuridae: (Black streak surgeon, *Acanthurus nigricuda*); Chaetodontidae: (Red tailed butterflyfish, *Chaetodon collare,* Indian vagabond butterflyfish, *Chaetodon decussatus)* Lutjanidae: (Blacktail snapper, *Lutjanus fulvus*) and Serranidae : (Grouper, *Epinephelus* sp).

Sea weed diversity

In Devagad Island, all the groups i.e., Green seaweeds (Chlorophyta), Brown seaweeds (Phaeophyta), Red seaweeds (Rhodophyta) are represented.

Chlorophyta: These species were found in the shallow areas of the Islands where there is plenty of sunlight and growing as thread like filament, irregular sheets. Eg. *Ulva sp., Enteromorpha sp., Caulerpa sertularioides* and *Caulerpa peltata.* During the survey, no prolific growth of *Ulva* sp. was observed which clearly shows that this Island was free of sewage pollution. The growth of tubular green seaweed, *Enteromorpha* sp. was less which also indicated that the Island is nutrient poor.

Phaeophyta: These species were found to be abundant, in particular *Sargassum* sp. dominated in terms of biomass. The species represented are *Sargassum wightii, Sargassum cinereum, Sargassum* sp. *Stoechospermum polypodioides, Padina tetrastomatica, Padina gymnospora, Turbinaria* sp. and few unidentified seaweed species. These seaweeds found typically in mid-depths grow at depth below green and above red algae.

Rhodophyta: These species were found to be less in abundant in this surveyed region. The species represented are *Gracilaria verrucosa* and *Gracilaria* sp. The seaweeds found attached in the rocks and produce slime to protect against drying out.

Phytoplankton diversity

Thirty one species of phytoplankton were recorded from the waters of rock oyster Island. *Alexandrium* sp (17.51%) dominated in the waters, followed by *Plagiotropis lepidoptera (12.46%) Chaetoceros lorenzianus (10%), Chaetoceros decipiens (8.08%) and Chaetoceros laevis (7.07%). The other species recorded were Asteromphalus flabellatus, Ceratium furca, Ceratium fusus, Chaetoceros lorenzianus, Catlanticus Coscinodiscus granii, Dinophysis miles, Dinophysis caudate, Guinardia striata, Hemiaulus sinensis, Haslea balearica, Licmophora* sp. *Lauderia annulata, Leptocylindrus danicus, Navicula* sp., *Odentella mobiliensis, Odentella aurita, Protoperidinium cerasus, Pyrophycus horologicum, Prorocentrum micans, Pseudo-nitzschia*

seriata, Planktoniella sol, Plagiotropis Lepidoptera, Rhizosolenia setigera, Rhizosolenia imbricate, Rhizosolenia shrubsolei, Surirella fastuosa, Thalassio nemanitz schioides.

Zooplankton diversity

Zooplankton collected from all the seven islands off Karwar were analysed and the results revealed that the waters off Karwar as very productive with a good standing stock of holo-plankton and a substantial stock of mero-plankton which together constitute the secondary production. The displacement volume of zooplankton ranged from 11.6 ml/100 m^3 to 26.68 ml/100m^3. Minimum values were recorded for Dodda kaki and Bide Island and the maximum values were recorded for Kurumagad Island. In numerical abundance, copepods dominated the zooplankton collected from all the seven islands. The cladoceran, *Evadne tergestina* came next in abundance in most of the islands. The zooplankton from Oyster Island was dominated by fish eggs followed by cladocerans, polychaete larvae and decapod larvae. In Sinna Kaki, Dodda Kaki, and Bide islands, bivalve larvae were abundant followed by polychaete larvae and *Lucifer*. The other dominant groups were amphipods, cirrepede larvae, chaetognaths, mysids , fish larvae and ostracods.

The zooplankton analysis of the waters of Devagad Island revealed that copepods ranked first with 64% abundance followed by free floating eggs (14%) and crustacean larvae (12%), 6 % of copepodite and 1% molluscan larvae were also recorded. A one percent abundance of annelid composed of *Travisiopsis spp.* and *Lopadorhynchus spp*.

Echinoderms: In the benthic fauna around Oyster Island, sea cucumber, *Acaudina molpadioides* (Semper, 1867) and *Holothuria (Mertensiothuria) leucospilota* (Brandt, 1835) and sea urchin, *Stomopneustes variolaris* were dominating on the sea bed. The density of sea cumbers was nearly 10 / m^2

Urchin barrens, is a phenomenon in which an area of the sea floor, where the

Stomopneustes variolaris

population growth of sea urchin has caused destructive grazing of seaweed due to the large congregation. The abundance of sea urchin is normally attributed to the less number of predators. The present investigation revealed the existence of such urchin barrens around Devagad Island.

Molluscan diversity: The molluscs were represented mostly by gastropods. However, the island has a significant settlement of the rock oyster *Saccostrea cucullata*, and therefore the Island is also known as *Oyster Island.* The gastropods comprised of 11 species belonging to 9 families.

Coral diversity

The Devagad Island harbours very few corals. The underwater videography revealed the presence of hard corals belonging to the family Faviidae. Some colonies were also collected belonging to the genera *Turbinaria*.

FISHING IMPACTS ON BIODIVERSITY LOSS

Research project:FISHCMFRISIL201201600016

Impact of trawling

Cochin

Species diversity: Forty one species of finfishes, 4 species of cephalopods, 6 species of bivalves, 27 species of gastropods, 6 species of shrimps, 11 species of crabs and 2 species of stomatopods were recorded from the by-catch/discards of trawl landings at the Cochin Fisheries Harbour. The juveniles of *Cynoglossuss* sp., *Lepturacanthus savala, Lagocephalus lunaris, Secutor insidiator, Uroteuthis (Photololigo) duvauceli, Sepiella inermis, Arca granosa, Turritella attenuata* were recorded. Juveniles of shrimps, *Fenneropenaeus* spp., *Metapenaeus monoceros, Parapenaeopsis stylifera* were also recorded. Juveniles of *Oratosquilla quinquedentata* occurred throughout. Live species of several

Live *Tibia* sp., from trawl by-catch

Live *Dentalium* sp., from trawl bycatch

gastropods of high commercial value such as *Arca granosa, Babylonia spirata, Bufonaria crumena, B. rana, Dentalium* sp., *Hemifusus carnaria, Murex trapa, Rapana bulbosa, Tibia insulaechorab* and *Turricula javana* were also recorded. The sea horse *Hippocampus kuda*, a species listed under the Schedule I of the Indian Wildlife (Protection) Act, 1972 was also recorded. Besides these, cephalopod egg capsules, gastropod egg mass, hermit crabs and polychaete worms were also recorded.

Juveniles of *Cynoglossus macrostomus* of size range 4.8 to 14.3 mm contributed nearly 2.34% to the trawl by-catch and occurred during March, May, June and January. A high percentage of *Epinephelus diacanthus* (42.8%) of 26 mm size was recorded in the trawl by-catch. Juveniles of *Lepturacanthus savala* (6%) of 12 to 36 mm size occurred during March, May, December and January. Juveniles of *Sardinella longiceps* of 5.2 to 18.5 mm size was recorded in trawls during December. Juveniles of *Secutor insidator* (2%) of 2.8 to 8.5 mm size occurred during May, December and March. Large quantities of juveniles of *Sepiella inermis* (6.7%) ranging from 1.5 to 6 mm was recorded during May to July, January to March. Live juveniles of *Arca granosa* (2%) ranging from 12 to 26.8 mm size was recorded during almost all months. Live as well as dead shells of gastropods were the major components of the trawl by catch/discards. Juveniles of all the commercially important shrimp species *(F. indicus, M. affinis, M. dobsonii, Parapeanopsis stylifera)* also were recorded. Large quantities of juveniles of squilla, *Oratosqulla quinquedentata* were also recorded.

Exploitation of juveniles : An estimate of the juveniles of finfish and shellfish landed at the Vypin fish landing centre and Cochin Fisheries Harbour (CFH) was made. At Vypin, juveniles of *Nemipterus randalli* was the highest landed followed by *Uroteuthis (photololigo) duvauceli* and *Cynoglossus macrostomus*. At CFH also, juveniles of *Nemipterus randalli* was the highest followed by *Uroteuthis (photololigo) duvauceli, Cystopus indicus* and *Cynoglossus macrostomus*.

Calicut

The low value by-catch caught in multi-day trawl operated from Beypore fisheries harbor was studied, based on the operation of a single trawl, during different months. The percentage of low-value by-catch to the total catch varied from 17.37 (October, 2014) to 34.78% (November, 2014). The juveniles of diverse resources including *Nemipterus* spp., *Rastrelliger kanagurta, Sardinella longiceps, Epinephelus diacanthus, Decapterus* sp., *Priacanthus* sp., *Saurida tumbil, Saurida undosquamis,* balistids, goatfish, *Platycephalus* sp., puffer fishes, eel, squids, cuttlefishes, crab *Charybdis feriatus* and *Sphyraena* sp. were observed in the by-catch. Juveniles as well as adults of flat fishes, silverbellies, *Stolephorus* sp., flying gurnard, *Therapon* sp., *Calappa* sp., *Matuta* sp., etc. were also observed in the low-value by-catch. The low-value by-catch is not allowed to land at the landing centre and therefore the entire catch of low-value by-catch is discarded into the sea.

Neendakara

In Neendakara, the landing of juveniles and by-catch was almost absent during the first half of the year, due to the self-imposed ban by the fishermen. However, fishermen started landing the by-catch and juveniles during the latter part of the year, stating reasons that the catch

has become scarce. The juveniles of nemipterids mainly comprised of *Nemipterus randalli, N. mesoprion* and *N. bipunctatus*. The juveniles of ribbon fishes and flat fishes were recorded during October, November and December. The hammerhead shark, *Sphyrna lewini* was common in the landings during the entire period. The by-catch comprised mainly juveniles of fishes belonging to Platycephalidae, Sauridae, Cynoglossidae, Bothidae, Soleidae, Trichiuridae, Nemipteridae, Mullidae, Lutjanidae, Leiognathidae, Fistulariidae, Scorpaenidae, Serranidae, Tetraodontidae, Apogonidae, Balistidae and Angullidae. Apart from finfishes, crabs, gastropods, bivalves and echinoderms were also very common in the by-catch landings.

Visakhapatnam

The non-commercial trawl by-catch constituted about 40% to the total trawl landings along the Visakhapatnam coast. A total of 204 species were identified from the multi-day trawl by-catch samples, which comprised of 130 species of finfishes, 57 crustaceans, 9 molluscs, 4 echinoderms, 2 marine turtles and 2 species of coelenterates. The juveniles of commercially important species contributed 62% to the total trawl catch. The most vulnerable groups encountered in trawl are the marine turtles (Olive Ridley turtle and green turtle) and elasmobranchs (juveniles of tiger shark and Bow mouth guitar fish).

Veraval

About 13500 t of low value by-catch (LVB) was landed with the main catch (20600 t), which formed about 40% of the total trawl catch (34100 t) at Veraval by single day trawlers. Highest percentage landing of LVB by single day trawl was observed during March, April and May, whereas lowest landing was observed during September.

About 36000 t of trawl catch was discarded, which constituted about 24% of total multiday trawl catch (1.52 lakh t) during January 2014 to December 2014. About 9600 t of LVB was also landed with the main catch (1.05 lakh t) which constituted about 6% of the total catch (1.52 lakh t) by multiday trawl during January to December 2014 at Veraval. The by-catch was higher during April, November and December and comparatively lower during May to August. The discards were higher during the months from October to December, while it was less during May.

The estimated total by-catch from trawlers (both single day and multiday) was 59400 t (comprising of 23000 t LVB and 36.4 lakh t discard) which formed about 32 % of the total fish catch landed (1.86 Lakh t) at Veraval during the period.

Mumbai

A total of 240 kg of bycatch sample from 56 hauls were collected and analysed from multiday commercial trawlers landed at the New Ferry Wharf, Mumbai during the year. A total of 142 taxa has been identified from the trawl by-catch subsamples, of which teleost consists of 85 species, elasmobranchs (6 species), crabs (14 species), cephalopods (7 species), stomatopods (4 species), molluscs (24 species) and sea snakes (2 species). It was found that the average by-catch landings contributed 54.65 % of the total catch landed by trawl at New Ferry Wharf landing Centre.

Drift Gill Net and Hook & Line

Cochin

At Cochin Fisheries Harbour, the total landings by all gears including trawl during the year was 38,061 tonnes and gears other than trawl contributed 68.8%. Among the different gears (other than trawl), the maximum was contributed by the combined gear Drif gillet + Hooks and lines (79%) and majority of the threatened fishes (Endangered & Vulnerable category of IUCN) were caught in the Drift gill net and Hooks & Lines.

Sphyrna lewini

Contribution of threatened (VU+EN) species landed in the total landings at CFH by gears other than trawl was 3.1%. Among the 15 species of threatened fishes recorded, *Sphyrna lewini* which belongs to the endangered category of IUCN contributed the maximum of 29%.

Among the threatened categories of fishes landed, a few species like *Carcharhinus longimanu*, *Manta birostris*, *Cheilinus undulatus*, *Sphyrna lewini* and *Sphyrna zygaena* are listed under Appendix II of CITES.

Bottom set gill nets

Sakthikulangara

At Sakthikulangara, the bottom set gill nets are used to target the crab *Portunus pelagicus.* The resources like sharks (*Chiloscyllium* sp.), rays and lobsters are incidental in this gear. Large quantities of seaweeds are also removed by this gear. The resources protected under the Indian Wildlife (Protection) Act, 1972 like the sponges and the gorgonids are landed and juveniles of hammerhead shark were also encountered in the landings.

Malleus malleus

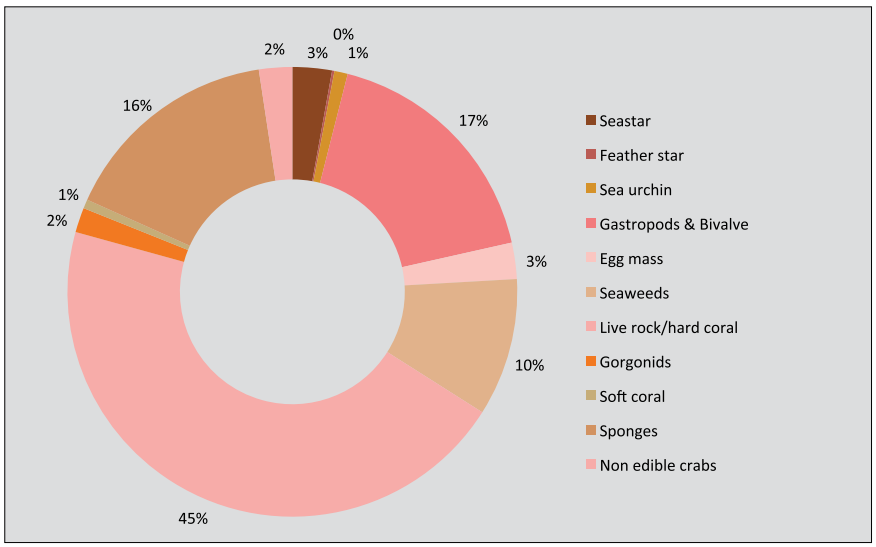
Muttom

The bottom set gill net locally called *'Ottakundu vala'* having large mesh size is operated for catching the rays. The non-target resources include large quantities of live rocks, large sized rare bivalves and gastropods like *Malleus malleus, Pinna bicolor, P. muricata, Lambis crocata*, star fishes such as *Protoreaster lincki* and cushion star, *Culcita novaeguineae*. The finfishes like *Plotosus* spp., *Lutjanus* spp., lethrinids, *Chlorurus sordidus*, *Plectorhinchus* spp. and *Scarus* spp. were also common in the landings.

Mandapam: Gulf of Mannar (Vethalai)

The bottom set gill net, locally called *'Singhi valai'* is operated by boats of length 28 to 32 ft fitted with engine of 20 HP capacity. About 3 to 5 fishermen go for fishing in one boat and each fisherman carry 3 nets, each of length 200m and height 1.25m. The soaking time of net is about 48 hours when targeting for lobsters; while it is 72 hours for chanks and other gastropods.

The targeted resources are the lobsters, *Turbinella pyrum* (Kuzhi Sanghu), *Chicoreus* sp. (Yanai Mulli Sanghu) and *Lambis* spp. (Iviral Sanghu). The non-target resources include the live rocks, seaweeds, different types of gorgonids, diverse types of gastropods (*Bursa spinosa*, *Hemifusus* sp., *Murex* spp., *Pteria* sp.), sponges, soft corals, starfishes, sea lilies, and many species of non-edible crabs.



Percentage of non-edible biota caught by the bottom set gill net *Singhi vala* in the Gulf of Mannar

Among the non-edible biota discarded, live rocks top the list with 45.28%. The molluscs and sponges occupy the second and third position with 17.52% and 15.89% respectively.

Tuticorin

The bottom set gill nets, locally known *'Nanduvalai'* used in Vellapatti landing centre has mesh size varying from 85 to 90 mm and target the crabs. The crab species *viz., Portunus pelagicus, P. sanguinolentus, Charybdis natator & C. lucifer* dominates the catch and other species that contribute to the catch are *C. feriatus, C. lucifer, C. orientalis, Calappa philargius & Podophthalamus vigil.* The catch also comprises of elasmobranchs (*Chiloscyllium griseum*), lobsters (*Panulirus homarus & P. ornatus*), gastropods (*Lambis* spp. & *Chicoreus* spp.), corals (*Acropora* spp., *Pocillopora* sp., *Turbinaria* spp., & *Montipora* spp.), starfishes (*Pentaceraster mammillatus & Protoreaster lincki*), sea urchin (*Temnopleurus toreumaticus & Salmacis virgulata*), finfishes, sponges, seaweed and seagrasses.

The total marine resource landed by *Nanduvalai* operated from Vellapatti during the year was 225.95 t by 5350 units (1 unit represents a single *Nanduvalai*). Crabs contributed 41.45 t (18.34 %) and non-target resources contributed 184.50 t (81.66%) which includes vulnerable resources 21.54

The bottom set gill net, *singhi valai* and the non-edible biota caught

Gastropod resources caught in the bottom set gill net, *singhi valai*

t (9.69%) also. The contribution of non-target resource landed are bony fishes (9.24 t; 20.89%), cartilaginous fishes (5.09 t; 2.25%), crustaceans which includes other crabs/lobsters (5.53 t; 2.45%), molluscs comprising gastropods / bivalves / cephalopods, (16.36 t; 7.24%), echinoderms comprising starfishes / sea urchins (7.62 t; 3.37%), corals include hard & soft mostly gorgonids (2.63 t; 1.17%), seaweeds / sea grasses (102.45 t; 45.34%), sponges (18.91 t; 8.37%) and others includes stones concrete/ cement blocks (7.91 t; 3.39%).

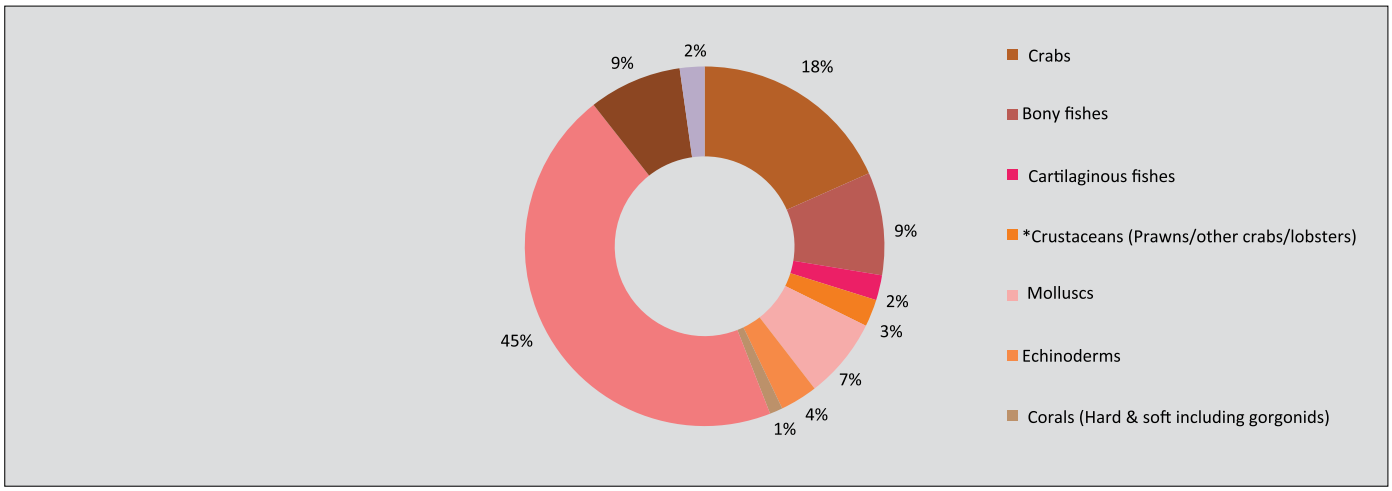
The highest total catch was observed during July and August, 2015 and accounts 27.78 t (12.29%) and 26.36 t (11.67%) respectively. The lowest total catch was recorded during April and May, 2014 which ranged between 5 t (2.22%) and 5.7 t (2.51%). The targeted crabs landed was 3.84 t which was 9.26% of the total crab catch. During the period April - May, the number of units targeting for crabs was less (187 nos.) when compared to the average fishing effort of 446 units. The average catch per unit effort (CPUE) for the total marine resources, target resource, non-target resources, vulnerable resources were 42.23 kg (28.4 to 55.50 kg), 7.75 kg (4.21 to 15 kg), 34.49 kg (15.69 to 47.55 kg) and 4.03 kg (0.0 to 7.70 kg) respectively.

Target and non-target resources landed during April 2014 to March 2015 by bottom set gill net, *Nanduvalai at Vellapatti*

Groups	Total Catch (t)	% of total catch
Target resource - Crabs	41.45	18.34
Non-target resource		
Bony fishes	9.24	20.89
Cartilaginous fishes (Sharks/rays/skates)	5.09	2.25
Crustaceans (Other crabs/lobsters)	5.53	2.45
Molluscs (Gastropods/bivalves/cephalopods)	16.36	7.24
Echinoderms (Starfishes, sea urchins)	7.62	3.37
Corals (Hard, soft & mostly Gorgonids)	2.63	1.17
Seaweeds/sea grasses	102.45	45.34
Sponges	18.91	8.37
Others	7.91	3.39
Total non-target resource	184.50	81.66
Total catch	225.95	100.00

Vulnerable / threatened / endangered groups

The major vulnerable/threatened/endangered groups like gastropods, hard corals, gorgonids, sponges, and sea cucumbers were encountered in the gill nets and trawl nets of Tuticorin coast. Other groups like the sea grasses, sea urchins, and starfish's occurrence were high in gill nets.



Percent contribution of marine resources in BSGN, Vellapatti (April, 2014 to March, 2015)

Protected species caught by bottom set gill nets at Vellapatti

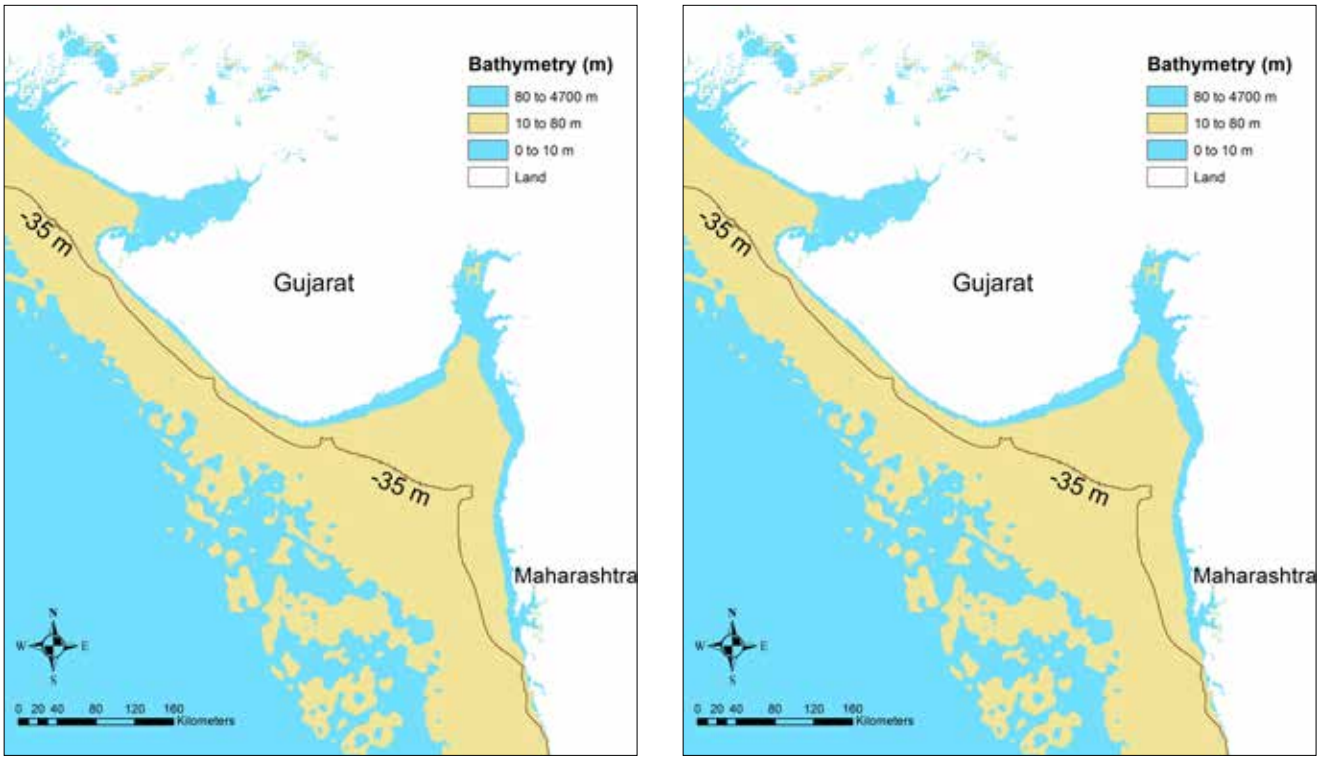
Species	Status
(as per the Indian Wildlife Protection Act, 1972)	
Lambis crocata	Schedule I - Part IV B
Fasciolaria trapezium (Pleuroploca trapezium)	Schedule I - Part IV B
Sponges	Schedule III
Sea cucumbers	Schedule I - Part IV B
Gorgonids	Schedule I - Part IV B
Hard corals	Schedule I - Part IV B

Assessing impact of fishing on marine biodiversity using fisher's perspective: A Saurashtra case study

The fishers' perception on the fishing and biodiversity changes were studied in Saurashtra region. A total of 200 fishers of age ranging from 24 to 70 years were interviewed. Some of the fishers had been fishing using different gears during their career but most of them were fishing in the trawling fleet.

Fishing depth and distance

Mann Whitney U test showed a significant difference between the depth the fishers used to fish when they started fishing and the depth at which they fish at present. In the past the mean value of fishing depth was 35 m whereas at present they are fishing from the depth of 200 m. The range of depth also showed substantial expansion, from 10 to 210 m in the past to 25- 500 m at present.



Perception on fishery

Some of the noteworthy outcomes were the declining catch in the near shore waters (upto 25 m depth) which resulted in the extension of the current fishing ground. A total of 40 species were mentioned as depleted, 13 as severely depleted and 5 as proliferated. Among those which got severely depleted, the most common ones were *Sphyrna mokaran, Sphyrna lewini, Lactarius lactarius, Tenualosa ilisha, Manta birostris, Mobula diabolus* and *Carcharhinus hemiodon*. A decline of population of all snappers was also frequently reported. Koth have shown a significantly high decline in its size over the years. Out of those species which have been mentioned as declined / drastically declined, 2 species are classified as Critically Endangered and 3 species are Endangered in the IUCN Red List. Only 9% of respondents mentioned about proliferations and the species that proliferated include *Trichurus lepturus, Parapercis alboguttata, Rastrelliger kanagurta* and members of the family Platycephalidae and jellyfishes.

Biodiversity valuation of marine ecosystems

Research project:FISHCMFRISIL201201500015

The Coastal districts have been identified as the administrative units and information was collected on area, population, active fishermen, households and length of coastline of 9 districts of Kerala, 13 districts of Tamil Nadu, 9 districts of Andhra Pradesh and 12 districts of Gujarat during the period. The data revealed that the coastal zone population was increasing, whereas the area of mangroves, length of mangrove fringed coastline, area of coral reefs showed a decreasing trend. Biodiversity valuation of different coastal ecosystem like mangrove average annual area loss, estuarine average annual area loss, brackish water average annual area loss, lakes average annual area loss, coastal area integrated loss was estimated for each ecosystem

by collecting past and present data. Measurement of values of ecosystem services was attempted, by first listing the ecosystem services into capture fisheries, aquaculture, and other sources of food, fibers, medicine, wood based energy and timber, mitigation of climate change, recreation, cultural amenity and aesthetics. The value of fish catch was calculated using the market price method of converting total catch of 62 groups of marine organisms using the average price of each group and converting into dollars. The value of other accessory services in the coastal areas like salt production, molluscan industries, pokkali, prawn farming and other production systems in the districts were also estimated.

Ecosystem services-Provisional and regulatory service.

Ecosystem services	Estuaries and marshes	Mangroves	Coral reefs & Islands	Salt pans	Sea grasses	Sandy shore	Inner shelf	Outer shelf	Ocean ridges	Deep ocean
Provisional services										
Food	■	■	■	■	■	■	■	■	■	■
Fibre, wood, fuel	■	■	■	■			■			
Salt and minerals			■	■		■	■			
Medicine and others	■	■	■		■		■			
Regulating Services										
Biological regulation	■	■	■		■		■			
Water storage, retention	■	■								
Flood/storm protection	■	■	■	■	■	■				
Waste disposal	■	■		■	■	■				
Erosion control		■	■		■					

Ecosystem services – Supporting and cultural services.

Ecosystem services	Estuaries and marshes	Mangroves	Coral reefs & Islands	Salt pans	Sea grasses	Sandy shore	Inner shelf	Outer shelf	Ocean ridges	Deep ocean
Supporting services										
Biochemical reactions	■	■			■		■			
Nutrient cycling &fertility	■	■	■		■	■	■	■	■	■
Prevention of saline intrusion	■	■								
Nursery for marine fauna	■	■	■		■		■			
Cultural services										
Cultural & amenity	■	■	■	■	■	■				
Recreational	■	■	■		■					
Aesthetics	■	■	■		■					
Species - human	■	■	■		■					
Education and research	■	■	■	■	■	■	■	■	■	■

Biodiversity value of mangroves, coral reefs to fisheries production (US dollars)

District	Mangrove depended species		Coral reef –depended species		Ocean depended species		Total value
	Production (Kg)	Value ($)	Production (kg)	Value ($)	Production (kg)	Value ($)	$
Tuticorin	17923699	1383535	33927002	2618834	12162510	938827	4941197
Tirunelveli	3466009	99969	6560660	189226	2351935	67836	357031
Kanyakumari	25174965	2520217	47652613	4770411	17083012	1710147	9000775
Thiruvallur	894251	8409	1692690	15917	606813	5706	30032
Chennai	9808087	67244	18565308	127284	6655488	45630	240158
Kanchipuram	1190469	15668	2253388	29658	807818	10632	55958
Villupuram	4634099	49993	8771687	94630	3144567	33924	178548

Integrative Taxonomy of Deepsea shrimp Resources along the Southern Coast of India

Research project: EF-13/DST

Samples of deep sea shrimps were collected twice in a month from Kalamukku and Sakthikulangara fish landing centres of Kerala and from Tamil Nadu, samples were collected twice during the year from Tuticorin, Chennai, Nagapattinam and Kanyakumari fish landing centres. Species of deepsea shrimps belonging to the major families *Penaeidae, Aristeidae, Pandalidae* and *Solenoceridae* were collected.

Kerala- Sakthikulangara: *Heterocarpus gibbosus, Plesionika quasigrandis, Plesionika martia, Heterocarpus woodmasoni, Acanthephyra sanguinea, Acanthephyra armata, Aristeus alcocki, Metapenaeopsis andamanensis, Penaeopsis jerryi, Solenocera hextii, Parapenaeus investigatoris, Hymenopenaeus equalis*.

Kalamukku- *Heterocarpus gibbosus, Heterocarpus woodmasoni, Plesionika quasigrandis, Aristeus alcocki, Metapenaeopsis andamanensis, Penaeopsis jerryi, Solenocera hextii, Parapenaeus investigatoris, Hymenopenaeus equalis*.

Tamil Nadu- Tuticorin: *Heterocarpus gibbosus, Heterocarpus woodmasoni, Plesionika quasigrandis, Plesionika martia, Aristeus alcocki, Metapenaeopsis andamanensis, Parapenaeus investigatoris, Hymenopenaeus equalis, Solenocera hextii*.

Chennai: *Aristeus alcocki*

Nagapattinam: *Heterocarpus gibbosus, Aristeus alcocki*

Kanyakumari (Colachel Fishing Harbour): *Heterocarpus gibbosus*

The morphological analysis of the specimens was performed using conventional methods. Sex was determined using binocular microscope by observing the shape of the endopodite in the first pair of pleopods and by the presence or absence of appendix masculina on the endopod of the second pleopod. Total length (TL), carapace length (CL) and wet weight (W) were

recorded. Two species *Plesionika quasigrandis* and *Oplophorus gracilirostris* were identified by both systematic and molecular methods

Molecular outputs

DNA of 15 species of deep-sea shrimps was extracted using the QIAGEN DNeasy Blood and Tissue Kit following the manufacturer's protocol. The extracted DNA was electrophoresed through 0.8% agarose gel containing ethidium bromide and quantified by using UV spectroscopy. The polymerase chain reaction (PCR) standardized, was used to amplify target regions of three mitochondrial genes 16S rRNA, COI and cytochrome b.

Standard PCR 25-µl reactions (2.5 µl of 10x assay buffer, 3.0 µl of 3 mM $Mgcl_2$,2.5 µl of 10 mM dNTPs,1.0 µl each of the primer (10 mM), 0.25 µl (0.05 U) of Taq DNA polymerase, 1.0 µl (1 µg) of DNA and 14.75 µl of milliq water) were performed in AB thermal cycler under the following conditions: initial denaturation 95^{0}C for 5 minutes followed by 35 cycles of 95^{0}C for 1 min, annealing 52-54^{0}C (depending on the species) for 1 min, extension 72^{0}C for 1.5 minutes and followed by chain extension at 72^{0}C for 5 minutes. Further the PCR products were purified by Gene JET PCR purificiation kit. The PCR products were electrophoresed through 1.5% agarose gel containing ethidium bromide and sequenced. All sequences were confirmed by sequencing both strands and were edited by using bioedit software (version 4.5). Molecular and morphometrically confirmed species sequences were submitted in NCBI.

Geospatial distribution and diversity in fished taxa

Research Project: FISHCMFRISIL201200100001

The species diversity in fished taxa along the Indian coast was analyzed, species wise and fishing zone wise from the marine fish landings data generated by the institute, during 2007-2013. Average taxonomic distinctness Delta+ and variation in taxonomic distinctness Lambda+ were worked out for each of the 75 fishing zones. Out of the 936 species landed along the Indian coast during 2007-13, Indian mackerel (*Rastrelliger kanagurta*) and Kingseer (*Scomberomorus commerson*) are the only two species that were landed in all the fishing zones. Quantity wise, the maximum landings during 2007-2013 were 3.77 million t of oil sardine (*Sardinella longiceps*) and 1.4 million t of Indian mackerel and the minimum were 16 kg of Fringe fin zebra sole (*Zebrias quagga*; in New Ferry Warf by mechanized dolnets in April 2012) and 29 kg of Mozambique large-eye bream (*Watssia mozambic*a; in Cochin Fisheries Harbour by gillnets in December 2013) respectively. There were 161 species that were landed only in one of the 75 fishing zones. Using information on latitude / longitude pertaining to each of the fishing zones its relationship with Delta+ and Lambda+ were examined. Significant positive regression coefficients were obtained between Lambda+ and longitude and between Delta+ and longitude. Funnel plot of Delta+ against number of species indicated that species diversity in fished taxa is high for Gujarat than Tamil Nadu though the number of species landed in Tamil Nadu is more than double that of Tamil Nadu. Bray-Curtis dissimilarity matrix were generated for the fishing zones and used for classification of the fishing zones through Multi Dimensional Scaling.

MARINE HABITATS

Sardine habitat changes and related fishery fluctuations

Research project: FISHCMFRISIL201201800018

The breeding and nursery grounds of Indian oil sardine *Sardinella longiceps* along Kerala coast were intensively monitored and the reasons for decline in oilsardine catch in 2014 elucidated. The sardine catch which is mainly from ring seine operations in Ernakulam District was 23879 t in 2013 which was less by about 4600 t from that of 2012. The catch further declined to 18281 t in 2014 (less by 5600 t from that of 2013).

Ecological reasons were identified for changes in the sardine habitat, one being early upwelling which must have prevented smooth entry of mature spawners into inshore waters during 2013 and another reason may be poor recruitment mainly due to environmental stress during peak recruitment period which prevented successful recruitment. Low dissolved oxygen levels in the inshore waters during August 2013 and salinity stratification would have affected larval/juvenile survival and the change in rainfall pattern also led to trophic changes which must have affected the recruitment. The impact of low recruitment in 2013 was reflected during 2014.

The diatom blooms were intense during the recruitment period but was dominated by the massive blooms of jellyfishes which again affected the recruitment. Four intense blooms of jellyfishes occurred from depth 12 to 40 m during June to September 2014. Two scyphozoan jellyfish *Lychnorhiza malayensis, Netrostoma coerulescens* (crown jellyfish) and two hydrozoan jellyfishes *Aequorea pensilis* and *Aequorea forskalea* increased in biomass and densities (200 to 400 no's m^{-3}) in the surface and column waters of the main pelagic fishing area. Predation by jellyfishes on the planktonic stages of sardine would have affected the recruitment. The reduced grazing pressure on phytoplankton also led to more frequent blooming of diatoms and dinoflagellates in the ecosystem. In addition to this, exploitation of juvenile sardines in some areas also affected the fishery.

Jellyfish *Lychnorhiza malayensis* caught in the fishing grounds off Central Kerala

Jellyfish Netrostoma coerulescens caught in the experimental fishing operations off Kochi

Jellyfishes caught in the experimental trawling off Kochi

Bio-geochemical process in a clam dominated estuarine ecosystem role of clams in recycling nutrients

A targeted study was conducted in Ashtamudi Lake to understand the ecological changes associated with clam bed and this was compared with a non clam bed area. The results indicated that clams play a significant role in bio-geochemical process.

In the clam bed area, oxidation reduction potential of surface sediment was double due to bio-turbation of clams and the amount of nutrients released to water was also high, compared to the nonclam zone. Beneficial effects on bio-geochemical processes were indicated in areas where clams are present and are fished. The environmental quality indicators remained well within permissible levels in clam bed with fishery, improving the ecosystem processes simultaneously. The study indicated that sustainable maintenance of clam beds with optimum fishery is necessary for the general ecological health of the Ashtamudi Lake.

Details of sediment quality parameters between fished clam beds and nonclam regions

Sediment quality	Clam beds with fishery compared to no clam scenario	Probable reason
Organic carbon %	≈2 times more	Due to clam faeces
Ammoniacal N ppm	≈1.8 times more	Due to clam faeces
Nitrite N ppm	≈2.5 times more	Due to clam faeces
Nitrate N ppm	≈1.09 times more	More oxidation due to clam bioturbation
Oxidation -Reduction Potential mV	≈2.2 times more oxidative	More oxidation due to clam bioturbation
Available P ppm	≈1.3 times more	More oxidation due to clam bioturbation
Sand %	≈1.2 times less	Due to clam faeces
Silt %	≈2 times more	Due to clam faeces
Clay %	≈1.6 times more	Due to clam faeces

Status of clam beds of Karnataka A rapid assessment of need for restoration

Clam production in estuaries of Karnataka registered a downward trend since 2013. Sand extraction, shell mining, habitat loss and industrial effluent discharge were some of the anthropogenic activities recorded in clam beds. Besides, the natural cyclic fluctuations in clam abundance and natural mortality associated with the monsoons, habitat alterations has adversely affected their substratum, added to the redistribution and reduction in the density of the associated flora and fauna. Six estuaries along the coast were found suitable for restocking of clams.

Trends in commercial clam production over time in estuaries of Karnataka

Estuary	1984**	2012-14	+/-
Kalinadi*	545	270*	-102
Gangavali*	0	94*	100
Aghanashini	755	2057	63
Sharavati*	0	0*	-
Venkatapur*	100	79*	-27
Uppunda	155	266	42
Coondapur	603	383	-58
Swarna-Sita	260	1565	83
Udyavara	225	195	-16
Mulki	2392	304	-687
Gurupur	1275	256	-397
Nethravathi	382	36	-955

*Enquiry data **Rao et al. (1989)

Main reasons for clam habitat and fishery reduction in different estuaries of Karnataka and prospects for restocking

Estuary	Clam production trend (+/-)	Natural clam resources	Overfishing	Sand extraction	Shell mining	Effluent discharge/ Industry	Salinity variations and rainfall influence	Habitat degradation	Status of Clam transplantation from other States	Immediate Restocking prospects	Remarks
Kalinadi*	-		×		×				×	×	Sand mining
Gangavali*	+		×	×	×	×			×		
Aghanashini	+			×		×	×				
Sharavati*	+/-	×	×	×	×	×		×	×	×	Less sheltered areas
Venkatapur*	-		×	×	×	×		×	×	×	Less sheltered areas
Uppunda	+		×	×	×	×		×	×		
Coondapur	-			×		×					
Swarna											
Sita	+		×	×							
Udyavara	-		×		×				×	×	Bridge construction
Mulki	-		×	×	×	×		×	×		
Gurupur	-		×		×				×	×	Sand mining, effluent discharge
Nethravathi	-		×		×				×	×	Sand mining, effluent discharge, less sheltered areas

Present × Absent

Mud banks of Kerala - Investigations on Ecobiology and fishery

The main fishery was composed of sardine, anchovies and shrimps. Observations made on the fishing indicated that the fishing area shifts between mud bank and non mud bank area as per the shoal movement. Ringseines were the main gear and this year also fishers from adjacent villages migrated to mud bank area during the monsoon period. The calm sea helps fishermen to launch and berth the fishing craft and fish traders to auction and sell the fish catch.

Continuous and focused eco-biological sea-based observations on mud banks of Alappuzha have given new information on less studied ecologically important groups like pelagic birds and sea snakes. The seabird diversity was more during upwelling period, similarly aggregation of beaked sea snake *Enhydrina schistosa*. The teleost *Trypauchean vagina* was present just before the formation of mud bank and was present throughout the mud bank period. Since this is a bottom dwelling fish, its occurrence in large numbers indicates disturbance or changes in the sea bottom. Dead *T. vagina* were frequently seen in the beaches /landing centres.

Fish landing centre in Alappuzha near to mud bank

Fishing by ring seines in the mud bank area off Purakkad in Kerala (note the unique calmness of the coastal waters during monsoon)

Fishermen sorting the catch collected from the mud bank region

Beaked sea snake in the mud bank catch

Cracks in the beach observed at Purakkad where mud banks are formed

Bloom of *Trichodesmium* was observed in the area of mud bank formation before the onset of monsoon and mud bank formation. Subsequently, bloom of *Fragilaria oceanica* was observed during the mud bank period and this species was observed in the gut of all pelagic fishes and even in shrimp gut. The entire coast was rich in diatom and the increase in phytoplankton was not restricted to the area.

Guts of almost all other fishes were empty. Fishing was mostly in the non mud bank area. On certain days fishes were seen to avoid mud bank region. About 32 species were observed in the catch and experimental fishing.

Mud cones, similar to mud volcanoes on land, were observed in the mud bank area very close to the coast. There were also cracks on the shore in the form of long splits with width (gap) of 5 to 8 cm during July/August. In the mud bank area the water usually was turbid. During the *Tricosdesmium* sp bloom, even the plankton sampling net got clogged with the species.

Mud cone observed in the mud bank region

Sample collected during bloom of *Tricodesmium* sp in the mud bank region

Pelagic and coastal birds

Twenty two species of seabirds belonging to 15 genera of 8 families were recorded in central Kerala. Among these, Boobies, Cormorants, Shearwaters, Petrels, Gulls, Terns, Noddies and Skuas abundance were estimated using band transect method. The maximum, 7500 numbers of Flesh-footed Shearwaters were observed on 26th June 2014. Oil sardine was the most preferred food for the Shearwaters followed by anchovies. The flesh-footed Shearwaters distribution and abundance was directly correlated to the occurrence of oil sardine shoal. Most of the terns preferred to feed on shrimps *Fenneropenaeus indicus* and *Metapenaeus dobsoni*.

Seagrass meadows of Lakshadweep

The percentage reduction in seagrass meadows since December 2011 to August 2014 was estimated as 61% in Agatti, 77% in Chetlat, 35% in Kavaratti and 70% in Kiltan. This situation calls for urgent steps to monitor the ecology and physicochemical parameters of water and sediment in the meadows while undertaking restoration programmes.

Mangroves and corals of Odisha

Studies were initiated in the mangrove ecosystem of Bhitarakaniaka the second largest mangrove of India with maximum biodiversity. The migratory birds at Chilka Lake were also documented. A coral reef area at a depth of nearly 50 m off the coast of Puri, Odisha was detected for the first time with the help of NGO.

Vembanad Lake: Rapid assessment of impact of anthropogenic activities

A rapid assessment of impact of various anthropogenic activities *viz.* clam fishing, shrimp farming, tourism activities, mangrove restoration, Pokkali farming (salinity tolerant rice variety) were compared with open water in Vembanad Lake in terms of benthos biomass, benthic biodiversity and sediment quality during October to November 2014. It was observed that the tourism focused area had extremely low abundance and diversity of benthos, compared to open water. Shrimp farming, Pokkali farming and clam fishing has not affected the benthic

Flesh-footed shear water *Ardenna carneipes* in the upwelling area off central Kerala preying on sardines

biomass, though the diversity varied in each site, with difference in the sediment quality in terms of organic carbon content and sediment texture. Mangrove restoration, though in the initial stage, showed better abundance of benthic biomass and improved sediment quality, compared to open water.

Utilisation of Seaweed resources

Research project: FISHCMFRISIL201203400034

From the Tamil Nadu coast 3778 t of dry seaweeds were harvested for algal polysaccharide extraction during the year 2014. A liquid fertilizer for foliar spray and dry seaweed mulch for soil application was prepared from brown seaweed *Sargassum* and evaluated for okra (*Abelmoschus esculentus*). Liquid seaweed fertilizer *Hypnea musciformis* was prepared and this gave good results in flowering plants. Decline in through mariculture production of *Kappaphycus* since August 2013 indicates need for carrying capacity studies and regulation of the number of rafts per unit area.

Pollution and litter in the coastal and marine ecosystem and their Impact

Research Project: FISHCMFRISIL201201900019

Microplastics: Microplastics were more in the mud bank region. This was reflected in the gut content of planktivorous fishes like sardine and anchovy. Plastic strands were observed in top carnivores like in *Trichurus* sp. indicating movement of plastic through food chain and their non-degradability. Plastic strings were observed in the stomach of the seabird *Sula dactylatra*. The gut contained digested food in fibrous form and in this 33 no's of plastic strands were found. There was a gradation noticed in the abundance of micro-plastics with respect to depth in the inshore waters off Tuticorin. The frequency of occurrence was higher at 5 m depth followed by 10 and 15 m depth and was rare at 20 m depth.

Microplastics were not observed in the benthos collected from 5 m and 10 m of depth off Cochin during 2014. At 20 m off Cochin, there was one occurrence of a plastic piece in the month of February, 2014. At 30 m off Cochin, there were three occurrences of plastics, including one of micro-plastic. One piece of plastic was observed in Feb 2014, one observed in July 2014 and 3 micro-plastic strands observed in October 2014.

How much litter in our fishing area? Plastics and other non-biodegrable debris from the fishing grounds off Cochin were recorded during the experimental trawling on board FRV Silver Pompano. The quantity of marine litter ranged between 15 g per 10 hectare (Feb 2015) to 5 kg/ 10 hectare (Nov 2014) and ranged from 0.06 to 8.06% of fish caught. Very high quantities of litter were observed in the mud bank area indicating litter from land flowing through river runoff. This may also be due to floating of submerged debris to bottom disturbance. Off Tuticorin, the density of litter was 135.5 g/gear from bottom set gill net, 123.5 g/gear from thallumadi and 34.4 g/gear from Karapad Bay.

Plastic Pollution in Dugong Habitats: Underwater survey of Dugong habitats in Gulf of Mannar was undertaken and the quantity of litter was assessed. Area surveyed - Mandapam, Kilakkarai, Erwadi and Periyapattinam. Mandapam - 4 plastics/50m LIT, Kilakkarai - 5 plastics/50m LIT, Erwadi - 8 plastics/ 50 m LIT and Periyapattinam - 3 plastics/50 m LIT.

Beach litter along the Indian coast: The National survey on beach litter along the

Marine litter obtained in the trawl operated in the mud bank region

Indian Peninsular coasts as well as the Laccadive Archipelago was completed. Thirty two major beaches along the Maharashtra coast were surveyed. Maximum plastic debris 7806 g 10 m^{-2} was observed nearshore at Versova in Mumbai. Marine litter in central Kerala during 2014 had an annual mean ranging from 6.83 - 12.2 g m^{-2}. Monitoring and awareness campaign conducted in and around Mangalore by CMFRI and other organizations has brought about positive changes in the beaches of Mangalore. Beach cleaning activities have been taken up with the involvement of the local corporations and people. Thus there was a reduction in quantity of marine litter in 2014 compared to that in 2013, 2012 and 2011 at all the three stations. The major beaches (21 nos.) of Goa were maintained by the tourist department. Vasco-Da-Gama beach had the highest litter of 1817.2 g m^{-2} followed by 502.3 g m^{-2} at Harmal.

Studies on fly ash deposition rate in the Karapad Bay, Tuticorin: The four months study indicated that the sedimentation of fly ash was comparatively higher towards the shore area and varied between 0.51 to 1.48 g day^{-1} with a mean of 0.92±0.4 g day^{-1} and between 0.35 to 1.23 g day^{-1} with a mean of 0.83±0.2 g day^{-1} in deeper area. Maximum deposition was noticed during October towards the shore area and during December in deeper area.

Living resources of the Gulf of Mannar: enhancing awareness and for conservation policy formulation

Research project: EF-28/MFF

Report on present status of Dugong and Cetaceans in Gulf of Mannar and Palk Bay has been submitted to IUCN-MFF. Awareness and capacity development workshops were conducted along with MSSRF in Ramanathapuram and Tuticorin. Interview survey was conducted along the Gulf of Mannar coast and management measures suggested. Research gaps and policy measures prepared and submitted.

Enhancing effectiveness of conservation potential of marine mammals in Indian seas

Research project: CP-1006299/GIZ-CMPA

Records on marine mammal stranding incidences along the Indian coast for the past 100 years have been collected. Website is being developed.

Indo Pacific Bottle nose dolphin *Tursiops aduncus* in Lakshadweep Sea

Stranding incidences of marine mammals were more in east coast than west coast of India in the past one year. The stranding incidences on sperm whale *Physeter macrocephalus* were unusual in east coast. There were 5 sperm whales stranded along the coast of Chennai and Puducherry in first week of March 2015. Dolphins in Lakshadweep seas were studied.

Delineation of ecologically sensitive areas (Mangroves)

Research project: EF-32/MoEF-NCSCM

The contiguous mangrove sites were identified and surveyed in ten districts (Kasaragod, Kannur, Kozhikode, Malappuram, Thrissur, Ernakulam, Alappuzha, Kottayam, Kollam and Thiruvananthapuram) of Kerala. Total extent of the mangrove patches covered is 1091 hectare with 65 contiguous mangrove patches were identified and delineated. Mapping and geo-referencing of all the mangrove patches was done using Quantum GIS. Among the 65 delineated patches, thirteen patches were identified as non-mangrove region and mangroves under private ownership. North Malabar region (Kannur, Kasaragod and Kozhikode) was found to be rich in diversity representing 13 species of mangroves. In South Kerala, Ernakulum District was rich in mangrove density. Malappuram, Thiruvananthapuram and Thrissur occupy less extent of mangroves in Kerala.

Rhizophora mucronata

Contiguous mangrove patches delineated and georeferenced in ten districts of Kerala

District name	Patch number	Total number of patches
North Kerala		
Kasaragod	1,2,3,4,5,6,7,8,9,10,11	11
Kannur	12,13,14,15,16,17,18,19,20,21, 22,23, 24,25,26,27,28,29,30, 31	20
Kozhikode	32,33,34,35,36,37,38,39	8
Malappuram	40,41,42,43,44	5
Thrissur	45,46,47	3
South Kerala		
Ernakulam	48,49,50,51,52,53,54	7
Alappuzha	55	1
Kottayam	56	1
Kollam	57,58,59,60,61,62	6
Trivandrum	63,64,65	3
Total patch In Kerala		65

Diversity of mangroves in Kerala

Overall 16 mangrove species and 28 mangrove associates were identified. During the study a new mangrove species *Avicenniaalba* was identified from Azheekal, Kollam and this species is reported for the first time in Kerala. Regionally threatened species such as *Lumnitzera racemosa*, *Excoecaria indica*, *Kandelia candel*, *Aegiceras corniculatim, Bruguiera sexangula* were identified from both the regions of North and South Kerala.

Distribution of pure mangroves in the ten districts of Kerala

Name of the Species	TVM	KLM	ALP	KTM	EKM	TCR	MLPM	KKD	KNR	KSD
Rhizophora mucronata		√	√		√	√	√	√	√	√
Rhizophora apiculata		√	√	√	√		√	√	√	√
Avicennia officinalis		√	√	√	√	√	√	√	√	√
Avicennia marina		√	√		√		√	√	√	√
Avicennia alba		√								
Bruguiera cylindrica		√	√	√		√	√	√	√	√
Bruguiera gymnorrhiza		√			√		√			
Kandelia candal			√		√	√	√	√	√	√
Bruguiera sexangula			√	√	√		√			
Sonneratia alba					√		√	√	√	√
Sonneratia caseolaris	√	√	√	√	√		√			
Excoecaria agallocha	√	√	√		√		√	√	√	√
Excoecaria indica			√					√		√
Aegiceras corniculatum		√				√	√	√	√	√
Lumnitzera racemosa		√								√
Ceriops tagal					√					

Sonneratia alba (inflorescence)

Sonneratia alba

Kandelia candel (inflorescence)

Avicennia alba (New report to Kollam, Kerala coast)

Public awareness program against marine litter - “BEWARE!!! CRAB!”

An installation art structure of a huge crab prepared with beach debris like waste plastics and discarded fishing nets collected from the Fort Kochi beach in Kerala was fabricated in the beach, to create awareness among the public on the impacts of plastics on the marine ecosystem. During the installation period, public were encouraged to deposit plastic bottles in an area marked for depositing which was then used for making the structure. This ensured public participation in this program.

The installation occupied 400 sq. ft with 17 ft hight and 19 ft width. This was exhibited in the beach till 30 December 2014 to 21 March, 2015 to Spread message of responsibility to the citizens to keep the beaches and environment clean and to protect our marine habitat and fisheries. Posters with messages for saving the ecosystems from marine litter were exhibited around the Installation art.

The “Mad Crab” - Installation art work at Fort Kochi Beach, Kerala

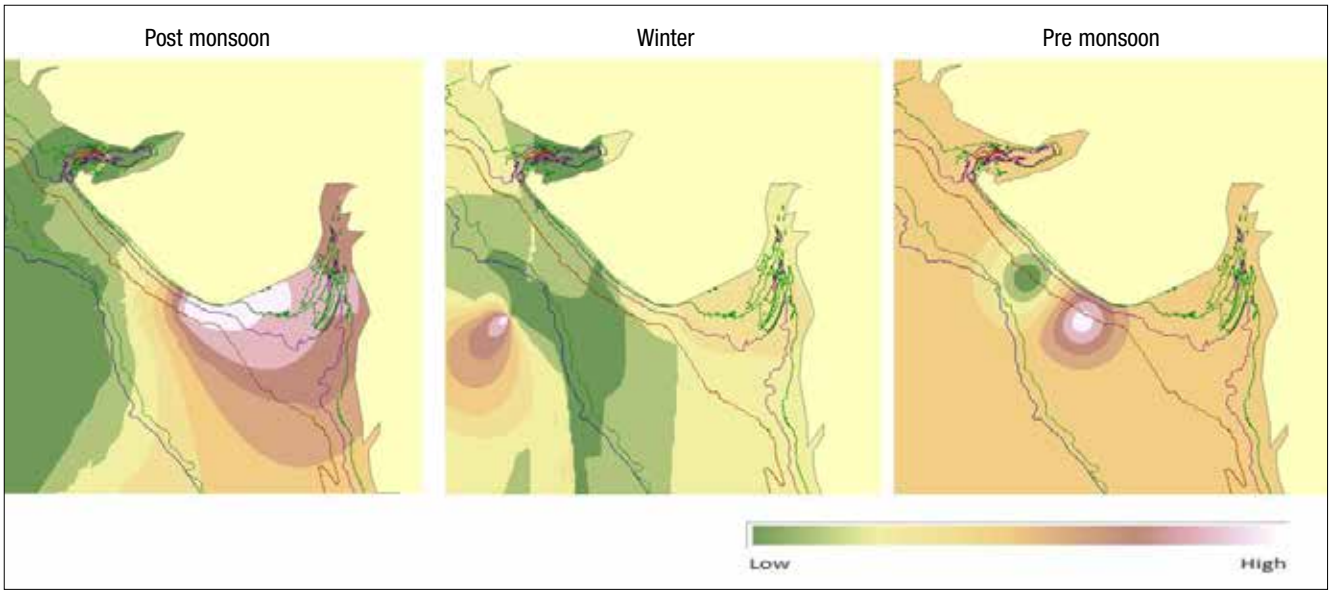
CLIMATE CHANGE & MARINE FISHERIES

National Innovations on Climate Resilient Agriculture (NICRA)

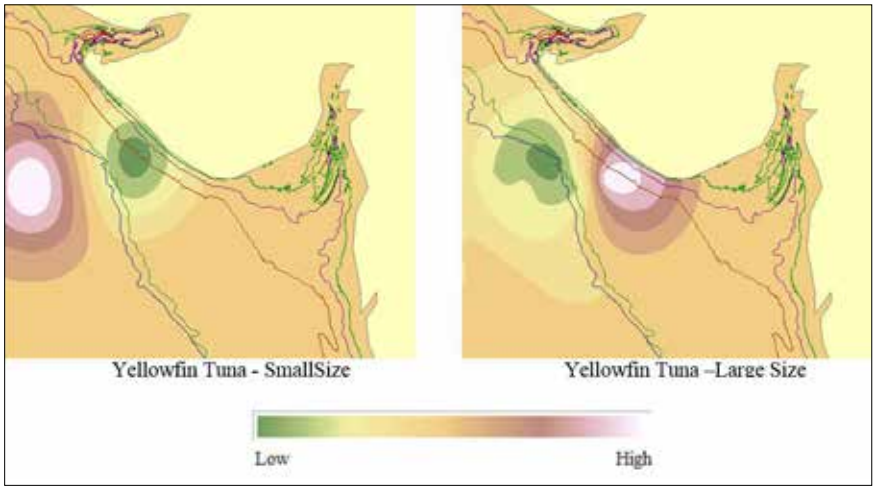
Research Project : EF-4/DARE/NICRA

Capture fisheries

Seasonal distribution pattern of skipjack and yellow fin tuna



Abundance of skipjack tuna *Katsuwonus pelamis* was found to be more in the offshores areas (100 m zone) during winter months of November, December and January where as it moves towards the inshore areas (30-50 m zone) during pre-monsoon (March, April and May) and post-monsoon (September and October) seasons. Both small and large sized tuna showed migration to the deeper waters during winter season. Differential distribution pattern of yellow fin tuna *Thunnus albacares* revealed abundance of small sized fishes in deeper areas, while the larger individuals showed aggregation near inshore areas at 30 m depths.



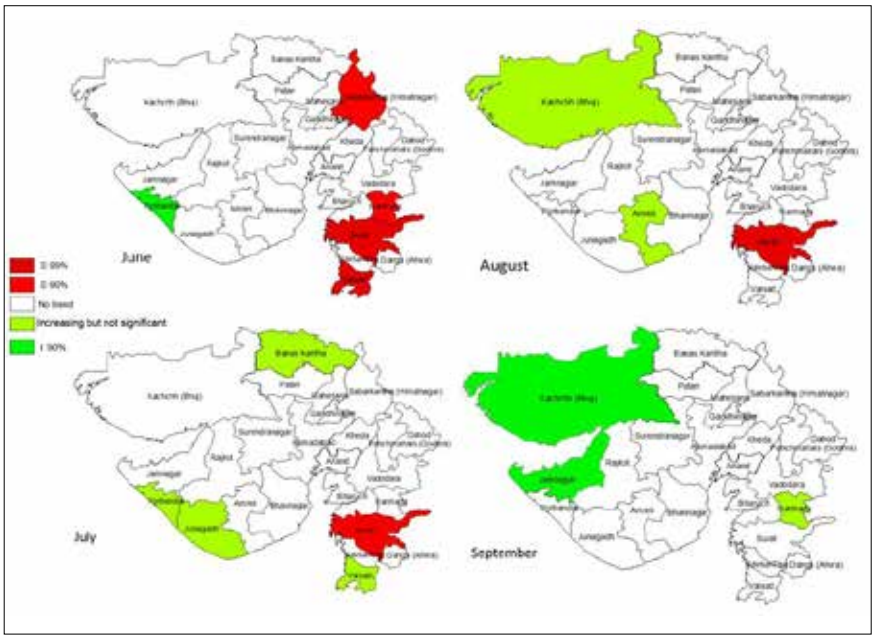
Effect of sea surface temperature (SST) on pelagic fishes

Strong association was found between the monthly average of percentage maturity data of ribbonfish (from 2007 to 2014) with corresponding night SST. An exponential model with R^2 value of 0.617 and <0.05 significance was found most suitable to explain this relation.

Pearson's correlation between maturity percentage and length at maturity of three pelagic species *viz.,* Bombayduck (*Harpadon nehereus*), Indian mackerel (*Rastrelliger kanagurta*) and ribbonfish (*Trichiurus lepturus*) showed that the variability in temperature negatively influences the length at maturity of Bombayduck and ribbonfish. The correlation was negligible and insignificant in case of Indian mackerel.

Trend analysis of rainfall regime in Gujarat

Spatio-temporal variability of rainfall for 26 districts of Gujarat was studied on monthly basis using the non-parametric test, Mannn-kendall (MK) test. Significant decreasing trend in rainfall regime was observed for Surat, Valsad and Sabarkantha in the month of June and July, where as significant increasing trend was observed for Jamnagar and Kuch in the month of September.



Linear regression equation was developed from the SST data collected from Gujarat waters from ICOADS and Air Temperature data from IMD :

$$SST_{(Gujarat\ Coast)} = 8.877+0.678\ T\pm 1.25$$

where T is atmospheric temperature of the region. The software developed using C# language is portable in nature and runs this specific model.

Climate change impact on trawl catch rates

SST plots showed 0.4^{O}C (average SST 28.38 ^{O}C) rise in temperature for Andhra Pradesh, 0.9^{O}C (average SST 28.33^{O}C) for Odisha and 1.0^{O}C (average SST 27.97^{O}C) for West Bengal from 1960-2010. Increasing catch rates in trawls were observed with decreasing SST along the NE coast of India. Average annual chlorophyll-a values were the highest for West Bengal with an average value of 4.04 mg m^{-3}, followed by Odisha with 1.27 mg m^{-3} and Andhra Pradesh with 0.47 mg m^{-3}. Peak chlorophyll-a values were recorded from July-September for Andhra Pradesh, July-November for Odisha and August-December for West Bengal during 1997-2010.

Spawning biology studies from Tuticorin

Spawning biology of Indian mackerel, oilsardine, anchovy, tunas *Katsuwonus pelamis, Euthynnus affinis* and *Thunnus albacares* was studied from Tuticorin. Aspects like sex ratio, Gonado-somatic index (GSI) and feeding pattern were studied in detail. In the case of mackerel, GSI showed higher values during March to July in 2011, whereas in other years, higher values were obtained during May to August.

Resource-wise fishery, reproductive biology and trophodynamics at Visakhapatnam and Digha

Biology and trophodynamics of Indian oilsardine, Indian mackerel, yellowfin tuna, skipjack tuna, barracuda, ribbonfish, threadfin breams, goatfish, croakers, lizardfish, penaeid shrimps and squid were studied at Visakhapatnam, Andhra Pradesh and Digha, West Bengal. Mean length, maturity percentage and GSI for most of the species was lower at Visakhapatnam in comparison to Digha. Prolonged breeding season was observed along Visakhapatnam coast as compared to Digha. Better feeding intensity was observed in fishes from Visakhapatnam and diversity of food items encountered in the stomachs in all species was comparatively more at Visakhapatnam. Annual mean temperature was less by 0.6^{o}C at Digha compared to Visakhapatnam

Spawning period of fishes at Visakhapatnam and Digha

Species	Visakhapatnam	Digha
Loligo duvaucelli	Around the year	Around the year
Nemipterus japonicus	Oct-Nov and Feb	Aug - Oct
Otolithes ruber	Nov-Jan and June	Nov and July
Trichiurus lepturus	July-Aug and Jan	June-July and Nov
Sardinella longiceps	May-July	July- Aug
Rastrelliger kanagurta	July-Sep and Feb	Aug-Nov

Spawning activity of fishes along north Tamil Nadu coast

Annual reproductive indices of four major fish species, Indian oilsardine, Indian mackerel, Japanese threadfin bream and ribbonfish *Trichiurus lepturus* were derived. Size at first maturity was estimated to be 209.7 mm for *R.*

kanagurta, 172.4 mm for *S. longiceps*, 618.8 mm for *T. lepturus* and 145.9 for *N. japonicus.*

Based on length at first maturity, length groups were categorised as juveniles, subadults, maturing, mature virgins and adults and their occurrence compared between years. The occurrence of adult *N. japonicas* showed positive correlation with rainfall and low temperature regimes. Adults were predominant in the samples of S. *longiceps*, *N. japonicus* and *T. lepturus*. Subadults and maturing individuals were found to be predominant in *R. kanagurta* collections. Dominance of these size groups on a continuous basis could be detrimental to *R. kanagurta* stocks in the region since the individuals are deprived of the chance to breed at least once, and the spawning stock biomass could come down.

Phenological parameters of threadfin breams off southwest and northwest coast of India

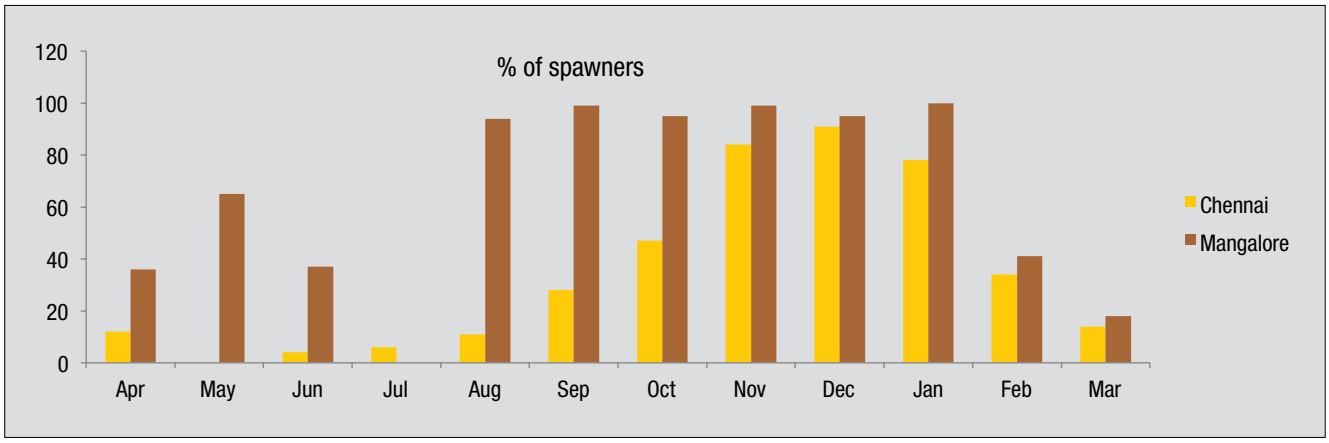
- Prominent difference was observed in the peak breading season of *Nemipterus japonicus* distributed along southwest coast of India compared to that of northwest coast. Spawning season along the SW coast extends from June to January and that of NW coast extends from September to March months.
- Size at first maturity of *N. japonicus* was much higher in the NW population than that of the SW population, the former being 180 mm and the latter being 134 mm
- Range of fecundity of *N. japonicus* is higher in SW population than that of the NW population.

Species	Region	Lat Long position	J	F	M	A	M	J	J	A	S	O	N	D
N. Japonicus	Southwest	76° 13'59" E 9° 58'00" N												
	Northwest	70° 22'00" E 20° 53'59" N												
N. randalli	Southwest	76° 13'59" E 9° 58'00" N												
	Northwest	70° 22'00" E 20° 53'59" N												

Spawning biology *Nemipterus japonicus* from Chennai and Mangalore coasts

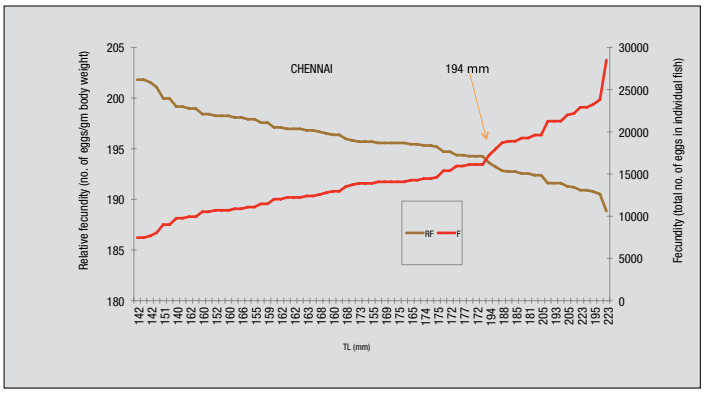
A marked difference was observed in the length at first maturity, asymptotic length and fecundity of the species along the two coasts. The species appears to mature earlier, is of lower life span and has a lower fecundity along the southeast coast. The analyses made in our study indicated a preference for lower temperatures with better reproductive output which is in accordance with the earlier study report of shift in the spawning peak of *N. japonicas* along the east coast towards cooler months (Oct-Dec) in the recent decade. The Lm50 was in the range of 140-145 mm at Chennai while at Mangalore it was 165-180 mm. L∞ estimates were 295 mm at Chennai

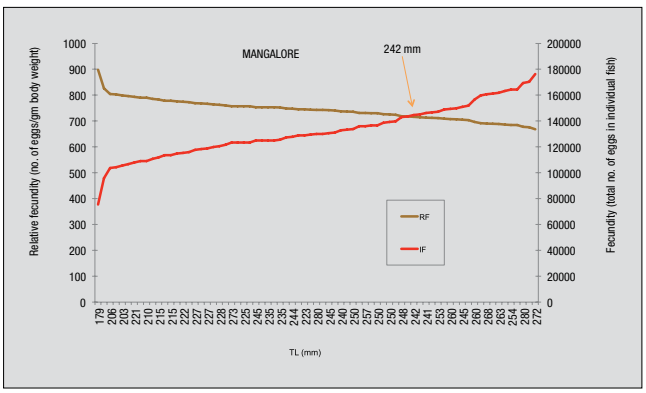
and 330 mm at Mangalore. Lm50/L∞ (%) was 47.5% at Chennai and 50% at Mangalore. Fecundity estimates were 7,440-37,627 at Chennai and 38,500-5,71,913 at Mangalore.



The relative fecundity was found to decrease with increase in length at both Chennai and Mangalore while the total fecundity increased with length. The point of crossover of RF and TF *vs.* TL was at 194 mm at Chennai and at 242 mm at Mangalore. These lengths were 66% and 73% in the L∞ at Chennai and Mangalore respectively. As the viability of the eggs will decrease naturally with approaching senility, if we presume that the maximum reproductive output will be during the phase between Lm50 and 70-75% of L∞, the proportion of decrease in RF towards the end of this phase is much higher in the species at Chennai than at Mangalore.

During 2011-2013, the average SST during April-September was 29.9°C at Chennai and 26.7°C at Mangalore while during October-March it was 27.8°C at





Chennai and 27.3°C at Mangalore. Comparing the SST at the two places, we find that the average SST off Chennai is always higher than that off Mangalore. However, corresponding to much higher SST during April-September off Chennai, the proportion of spawners was only 12.1% at Chennai, as against 60.1% at Mangalore. During October-March, the difference between the SST at the two centres was relatively less. The proportion of spawners was 74.7% at Mangalore and 58% at Chennai. The monthly SST was found to be higher at Mangalore during November, December and January. Percentage of spawners was maximum during these 3 months at Chennai, almost on par with that at Mangalore, particularly in December.

Integrated District Level Adaptation and Mitigation (IDLAM)

Vulnerability assessment

Vulnerability indices of selected coastal villages of Tamil Nadu and Andhra Pradesh were done. The impact of climate change on the five different parameters *viz.*, Demography, Occupation, Infrastructure, Climate components and Fishery components were assessed using the application of PARS methodology and it was indicative that climate change has mostly impacted fishery followed by economic and environmental factors in coastal villages of Tamil Nadu.

Carbon footprint in Life Cycle of marine fisheries

Carbon footprint contribution of marine fisheries activities at selected fishing harbours of Andhra Pradesh and Tamil Nadu were estimated. In Andra Pradesh, the study covered Visakhapatnam, Kakinada, Nizamapatnam and Machilipatnam. Fuel and electricity consumption per kg of marine fish was found to be on an average 0.43 l and 0.24 kWh at Visakhapatnam, 0.41 l and 0.15 kWh at Kakinada, 0.52 l and 0.26 kWh at Nizamapatnam and 0.48 l and 0.21 kWh at Machilipatnam. Mechanised catches contributed 80 – 85% of the total fuel burnt and 79 – 90% of the total electricity consumed. The harvest phase (88 – 93%) burnt the most fuel, while the post-harvest phase (51 – 62%) contributed the most to electricity consumption. Emission intensity per kg of marine fish was 0.34 kg C and 1.26 kg CO_2 in Visakhapatnam, 0.31 kg C and 1.16 kg CO_2 in Kakinada, 0.41 kg C and 1.50 kg CO_2 at Nizamapatnam and 0.37 kg C and 1.37 kg CO_2 at Machilipatnam. Fuel and electricity consumption and emission intensity was high for mechanised landings and low for motorised landings. The highest emissions were recorded in the harvest phase at all the places of Andhra Pradesh.

In Chennai Fisheries Harbour total carbon footprint during 2012 was 64 million kg CO_2e. Mechanized sector emitted 60.65 million kg CO_2e (94.5% to total) and motorised sector contributed 3.53 million kg CO_2e. Harvest phase emitted 89.7% of total carbon followed by post-harvest phase (5.59 million kg CO_2e) and pre-harvest phase (1.02 million kg CO_2e).

In harvest phase, fishing was the major contributor which emitted 85% of total carbon. Diesel was the key source of emission at harvest phase and contributed 54.5 million kg CO_2e. Emission in pre-harvest phase was mostly by electricity used (68 %) followed by diesel burnt. In post-harvest phase 78% of carbon was emitted by LPG use and 18.92% was by diesel burnt. In harvest and post-harvest phases, trawl emission was more (66.49 and 81.4% to total) where as in pre-harvest phase, gillnetters emitted 54% of total. Emission by motorised fishing was 0.17, 2.85 and 0.51 million kg CO_2e at pre-harvest, harvest and post-harvest phases respectively.

In Tuticorin the average quantity of diesel consumed during a year was worked out as 20.3 million litres, which emitted 54.1 million kgCO_2e. Total emission from ice used in the boats was 1.3 million kg CO_2e and that used in preservation for transportation to the retail or whole sale points was 6.7 million kgCO_2e. Average emission by all the vehicles together as a result of fuel combustion was 12.3 million kgCO_2e. Total emission from harvesting and post-harvesting involving preservation and transportation to the point of retail or whole sale points was 74.85 million kgCO_2e. Out of the total emission, 72% was from

Seaweed culture integrated to cage farming

fuel combustion for fishing. The average production was 4,19,14,507 kg. The average carbon foot print from trawl fishery resulting from all the above mentioned activities was estimated as 1.77 kgCO_2e per kg of fish caught.

Mariculture

Trial on Integrated Multi Trophic Aquaculture (IMTA) in a participatory mode

The Mandapam Regional Centre of CMFRI standardised the seed production technologies of cobia and silver pompano and the farming methods of the same were also successfully demonstrated.

The concept of integrated type of farming was imparted to the fishermen group of Munaikadu Village who are already practicing commercial level seaweed farming. A total of 652 kg of cobia was harvested. The length ranged from 59 to 83 cm and weight ranged from 1.8 to 4.2 kg (average weight 3.25 kg). It was observed that the seaweed rafts integrated with cobia cages had a better average yield of 225 kg per raft in contrast to 150 kg per raft, for others which were not integrated.

Pen farming of milkfish at Pillaimadam

A trial on pen farming of milkfish *Chanos chanos* was initiated at Pillaimadam Lagoon in a participatory mode with a fishermen group of Vedalai Village, Ramanathapuram. After rearing for a period of 10 months, a total of 250 kg of milkfish were partially harvested with an average length and weight of 33 cm and 300 g respectively. Fishes were immediately sold in nearby fish market and the remaining fishes are being reared in the pen with harvesting plan during the fishing ban period aiming at fetching a better price.

Cage farming of silver pompano fed with low value fishes

A total of 2,100 silver pompano fingerlings produced from Mandapam Regional Centre with an average size of 14.90 cm total length and 48.80 g weight were stocked in HDPE circular sea cage and fishes were fed with

Launching of cages

minced low value fishes. After a period of 240 days of culture, the fishes attained an average length of 23.65 cm and average weight of 207.43 g in the grow-out cage. The grow-out culture of pompano is in progress.

Climate resilient alternative food crops among the halophytes

The following halophytes were identified as potential alternative food crops

Common Name	Scientific name	Morphology of edible parts	Nutritional significance	Habitat
Tiger nut/ earth almonds (Kairikaya, Kuzhimuthanga)	*Eleocharis dulcis*	Rhizome (tuber)	Dried tigernut has a smooth tender, sweet and nutty taste. It can be consumed raw, roasted, dried, baked or as tigernut milk	Saline marshy wetlands
Wild rice	*Porteresia coarctata*	Seeds	Cooked and consumed	Salt marshes along the coastal plains of Bay of Bengal and the Gulf of Kutchch
Mangrove apple	*Sonnerati caseolaris* & *Sonneratia alba*	Fruit pulp	Eaten raw, Juice and Jam	Mangrove areas
Mangrove fern	*Acrostichum aureum* & *Acrostichum speciosum*	Tender shoot, runner (fiddle heads)	Consumed as steamed vegetable	Mangrove areas
Salicornia (*Sea asperagus*)	*Salicornia biglovii* & *Salicornia brachiata*	Leaves and seeds	Seeds yield edible oil rich in highly poly unsaturated oil. Leaves are eaten as salad and cooked as vegetable	Sandy coastal plains
Seagrass seeds	*Enhalus acoroides*	Fruits and seeds	Starch filled seeds	Reef flats and shallow coastal plains
Seaweed *(sea lettuce)*	*Ulva reticulata*	Entire plant (thallus)	Crude protein 28.5%, Crude fibre 35%, PUFA rich	Intertidal region
Seaweed	*Gracilaria crassa*	Entire plant (thallus)	Crude protein 13.2%, Crude fibre 38.7%	Intertidal region

Technology demonstration

Technology demonstration activities were carried out at Veraval, KVK Cochin and Karwar centres of CMFRI. At Veraval "*Awareness programme on Climate Change and Gujarat Fisheries*" was conducted. Vulnerability of the coastal fisher folk was assessed at district level and based on the results, one day *"Fish-farmer awareness meet"* was organized at Navabunder, which dealt with climate change, factors leading to climate change, contribution by human beings, how they can sustain the effects of climate change and on various adaptation

and mitigation options that they can act upon. Results of the study were also shared with the participants and the issues pertaining to their problems related to fishery were also addressed. Leaflets/pamphlets addressing Climate change vulnerability assessment and open sea cage were distributed to generate more awareness. Surveys were also initiated on "*Carbon foot-printing from house hold and mariculture"* and "*Role of women in fisheries*" along the northwest coast and both the surveys were successfully completed.

Karwar Research Centre of CMFRI is actively undertaking participatory programmes with the support of Govt. of Goa. Fishermen groups were identified from different areas of Goa as well as Karwar and trainings and awareness programmes were given. Cage farming of cobia, pompano and seabass were successfully demonstrated with the technical support and consultancy from Karwar Research Centre of CMFRI.

Handon training programme on cage farming of marine finfish for fishermen selfhelp groups from Goa

At Cochin, integration of Scientific finfish farming along with traditional pokkali paddy was done. Water quality of the pokkali fields was monitored to prevent adverse effects of fertilizers upon the fish. Demonstrated farm gate markets for live caught Karimeen (pearlspot) and Thirutha (Mullet) grown organically in Pokkali fields. Brand naming and implementation of farm gate market for the pokkali fish was done to ensure safe-to eat product for the consumers at a reasonable price while enhancing the income from Pokkali farming towards its sustainability.

CMFRI developed a formulated feed for pearl spot and was launched by KVK, Ernakulam in the brand name *'Pearl Plus'*. Entrepreunesrhip development programme on Climate resilient aquaculture was organized by Kishi Vigyan Kendra at CMFRI, Cochin with the participation of educated professionals.

Cages in pokkali fields.

EDP in climate resilent aquaculture

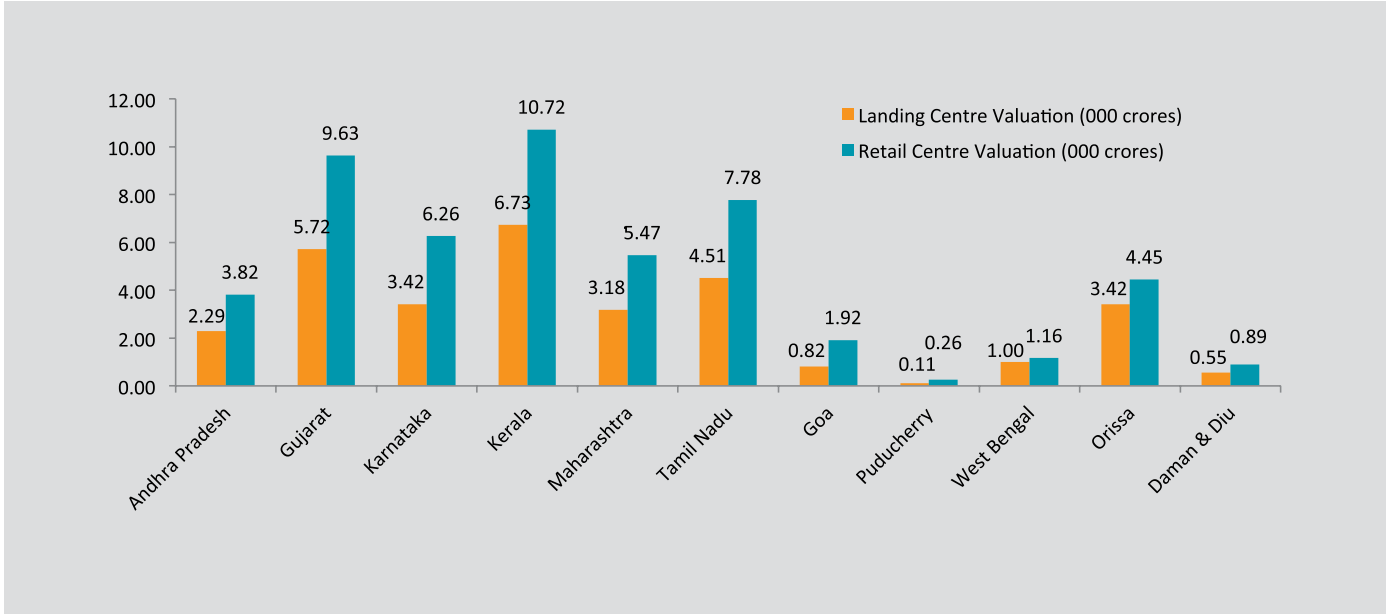
ECONOMIC SUSTAINABILITY AND SOCIO-ECONOMICS

Valuation of marine fish landings

Research Project: FISHCMFRISIL201202000020
Research Project: FISHCMFRISIL201202000023

The valuation of marine fish landings in India during 2014 was estimated at ₹31,750 crores at landing centre (LC) level and ₹52,360 crores at the retail centre (RC) level. The value at the landing centre level registered an increase of 8.10 per cent while that at the retail centre level increased at the rate of 12.1 per cent over the previous year 2013.

The States of Gujarat (17.8 % at LC level, 19.1 % at RC levels) Kerala (17.5%, 15.8 %) and Tamil Nadu (12.5 %, 13.2 %) accounted for the maximum share of the value of marine fish landings both at landing centre and at retail centre levels.



Valuation across value chains ('000 crores)

Amidst being third in the fish landings in the country the state of Kerala has the highest realisation of prices at the landing centre and retail centres registering a growth of 18.28 % and 19.38 % respectively over 2013. The state of Gujarat followed it by percentage increase of 7.52 and 8.81 at the landing and retail centre respectively over 2013. The average unit price per kg of fish at the landing centre level was ₹88.69 registering an increase of 14.14 % over the previous year. The unit price per kg at the retail level was ₹146.27 per kg, an increase of 18.37 % over the previous year.

The average species composition of the valuation of landings for the major valued species is indicated in Table

Species	Share in total landings	Share in point of first sales	Share in point of last sales
Penaeid shrimp	5.81	13.96	15.51
Non-penaeid shrimp	5.11	11.26	14.30
Ribbon fishes	5.87	8.44	6.85
Indian mackerel	6.59	7.31	6.38
Oil sardine	15.35	7.18	7.06
Croakers	4.52	4.75	3.93
Cuttlefish	2.35	3.35	2.66
Squids	2.33	3.3	2.79
Seer fish	0.88	2.98	2.88
Silver pomfret	0.84	2.36	2.67
Threadfin breams	3.83	1.86	2.22
Other sardines	5.77	1.56	2.31

Though the shrimp (both penaeid and non-penaeid) contribute to just 10.92 % of the volume of landings, it contributes to 13.96 % (penaeid) and 11.26 % (non-penaeid) in terms of value. On the contrary the oil sardine which contribute to 15.35 % of total landings only provide 7.18 % to value of landings.

The marketing efficiency, measured the average percentage share of fishermen in the consumer's rupee worked out to 61 % registering a reduction of 3.5 % compared to the previous year.

The estimated private capital formation (investment) in Indian marine fisheries sector worked out to ₹21023 crores out of which the investment in mechanized sector worked out to ₹19407 crores (92.31 % of the total investment), in motorized sector worked out to ₹1,426 crores (6.78 %) and in non-mechanized sector worked out to ₹191 crores (0.90 %).

State-wise sector-wise private capital formation in marine fisheries sector in India 2014 (₹ In crores)

STATES	Investment in mechanised sector	Investment in motorized sector	Investment in non-mechanised sector	Total investment
West Bengal	3,134	0	11	3146
Odisha	672	78	17	768
Andhra Pradesh	827	215	67	1109
Tamil Nadu	2,799	499	39	3337
Puducherry	107	31	2	141
Kerala	1,657	224	22	1903
Karnataka	1,048	150	11	1209
Goa	468	26	1	494
Maharashtra	3,649	31	10	3690
Gujarat	4,754	165	7	4926
Daman &Diu	292	7	1	301
Total	19,407	1,426	190	21,023
% to total	92.31	6.78	0.90	100.00

The return (gross return) to investment ratio worked out to 1.56 based on the value at the landing centre level and 2.56 based on the retail market level estimates.

The analysis of the economic performance of different craft gear combinations indicated that the average input-output ratio ranged from 0.40 to 0.72 in the mechanised sector, 0.31 to 0.42 for motorized sector and around 0.11 to 0.22 for non-mechanised sector. The average input-output ratio across the sectors worked out to 0.36 and the average capital productivity worked out to 0.63.The input-output ratio plays a significant role in estimation of the contribution by the fisheries sector to the country's GDP.

MARKETS, TRADE AND ENVIRONMENT

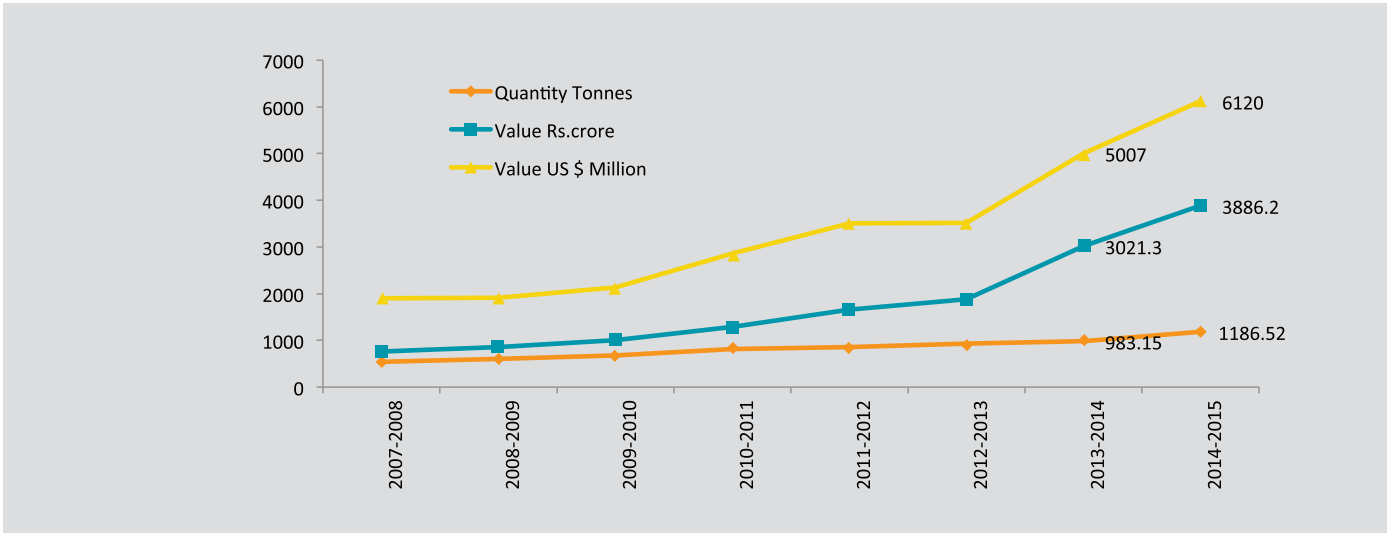
Supply chain management in marine fisheries sector

Research Project: FISHCMFRISIL201202000023

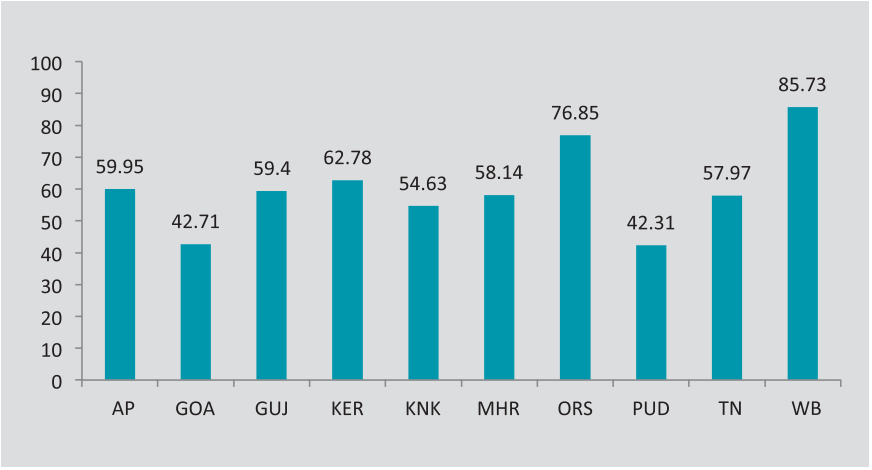
Amidst recession the export sector continues to grow unabated with an average increase of 11.07 % in terms of quantity, 21.82 per cent in terms of value compared to 7.56 % and 12.08 % during the pre-recession period .The export sector is booming with an expected forex earnings of over 6.12 billion dollars with an increase of 17.14 % in terms of quantity, 18.18% in value in comparison with year 2013.

Marketing efficiency

The analysis of state wise marketing efficiency indicated that West Bengal is having the highest market efficiency (85.73), whereas Puducherry registers the lowest marketing efficiency (42.31).

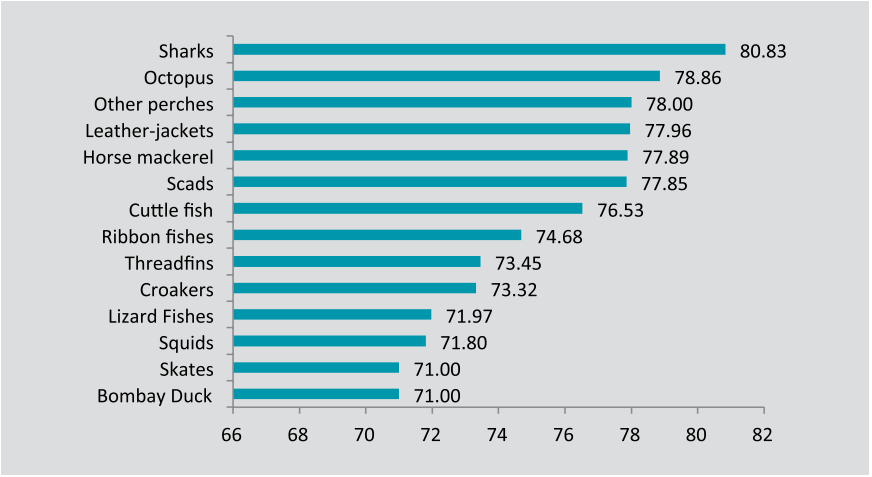


Indian Export - Recession and forward

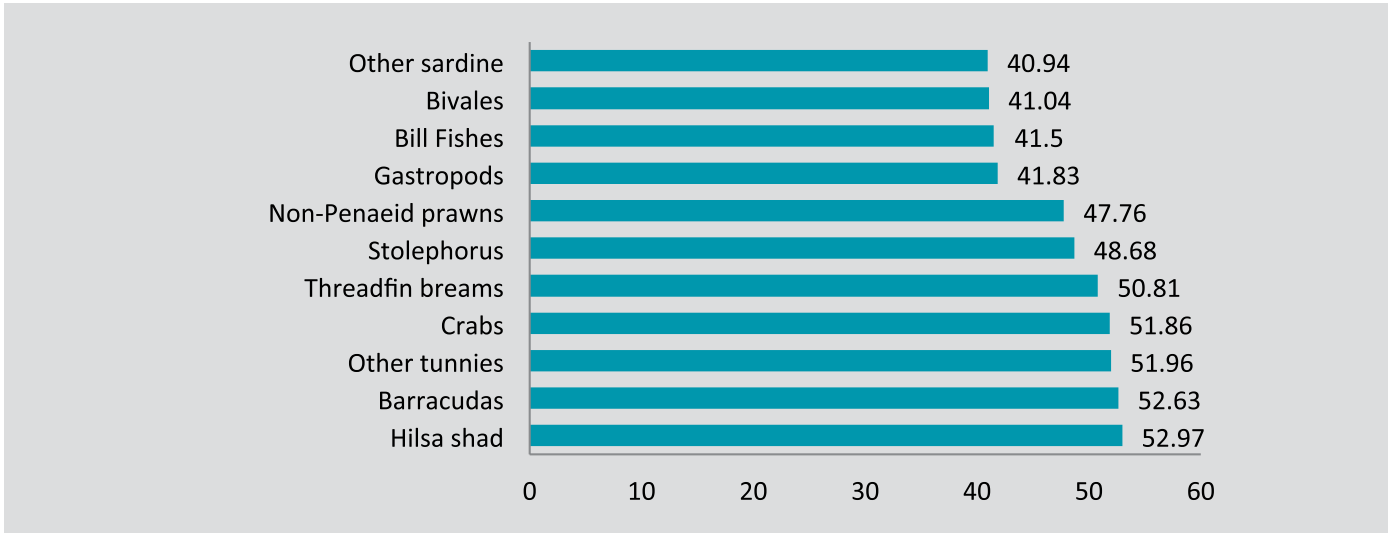


State wise marketing efficiency

The species wise market efficiency is calculated on the basis of the Producer's Share of Consumer Rupee (PSCR) % based on which, the species were categorized as high market efficient and low market efficient



High market efficient species (PSCR in %)

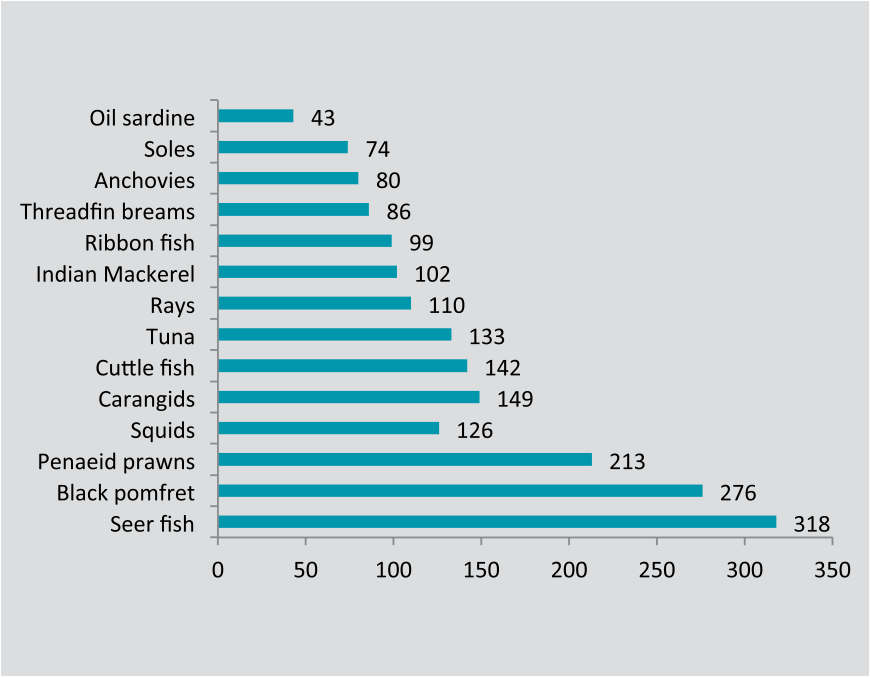


Low market efficient species (PSCR %)

I. Price realisation of major species traded across the landing centres and retail centres

Average landing Centre Price realisation - Major species

The average landing centre price for major species in India is given. The Figure depicts a wide variation in prices across species. Seer fish registers the highest price ₹ 318, whereas, Oil Sardine realizes the lowest price of ₹43 per kg.



Average landing centre price realisation - All India (Rs/kg)

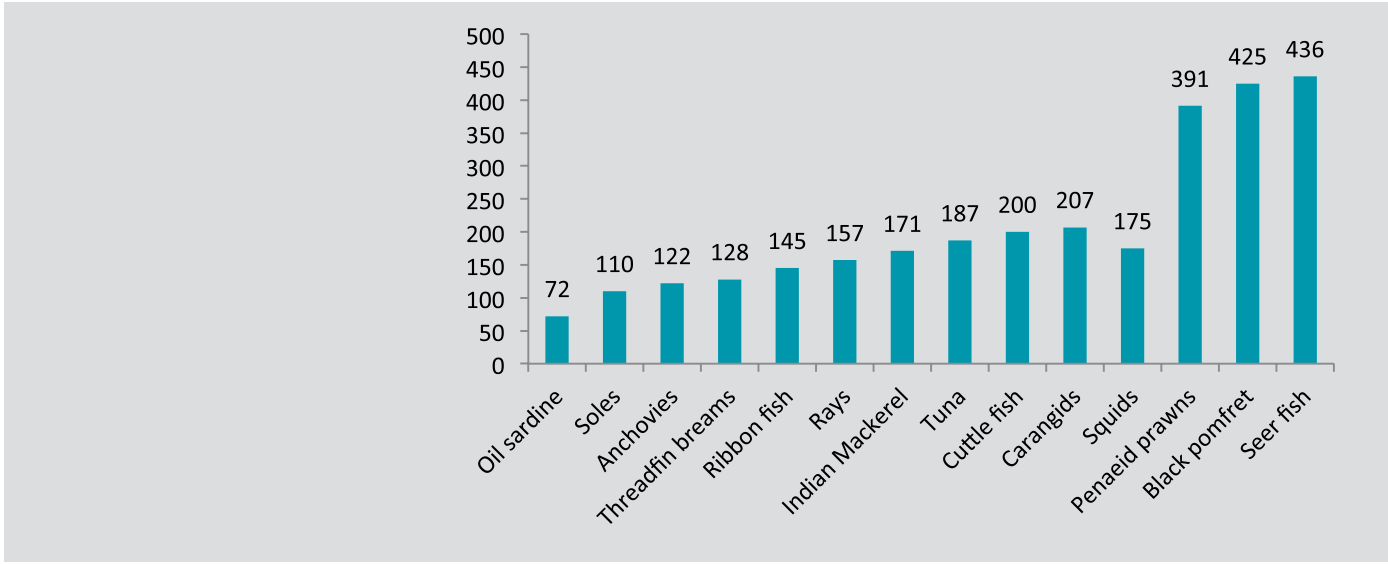
The average landing centre prices of important species- across coastal states is given. The price range of oil sardine ranged between ₹18 and ₹70, while that of black pomfrets ranged between ₹178 and ₹360.

Average landing centre prices (₹) of important species- across coastal states

Species	GUJ	MAH	GOA	KNK	KER	TN	AP	ORS	WB
Oil Sardine	22	55	46	44	45	21	18	65	70
Indian Mackerel	85	128	130	98	95	119	50	127	87
Anchovies	58	65	42	113	94	133	40	110	61
Soles	68	78	58	142	63	66	23	85	83
Thread fin breams	48	82	62	65	115	131	33	125	115
Carangids	135	168	152	140	155	150	125	175	140
Rays	92	125	110	164	90	92	48	135	135
Tuna	108	134	95	113	118	122	95	180	230
Ribbon fish	82	79	115	97	135	100	32	145	110
Squids	129	162	168	134	140	163	90	220	160
Cuttle fish	132	148	162	125	115	131	90	219	160
Penaeid prawns	202	252	248	321	220	247	255	275	295
Seer fish	194	290	340	468	310	393	148	375	344
Black pomfrets	178	360	280	270	290	288	205	315	298

Average Retail Centre Price realisation - Major species

The average retail centre price for major species in India is given. The prices range from ₹ 72 to ₹436, with seer fish priced the highest, while oil sardines were priced the least.



Average retail centre price realisation - All India (Rs/kg)

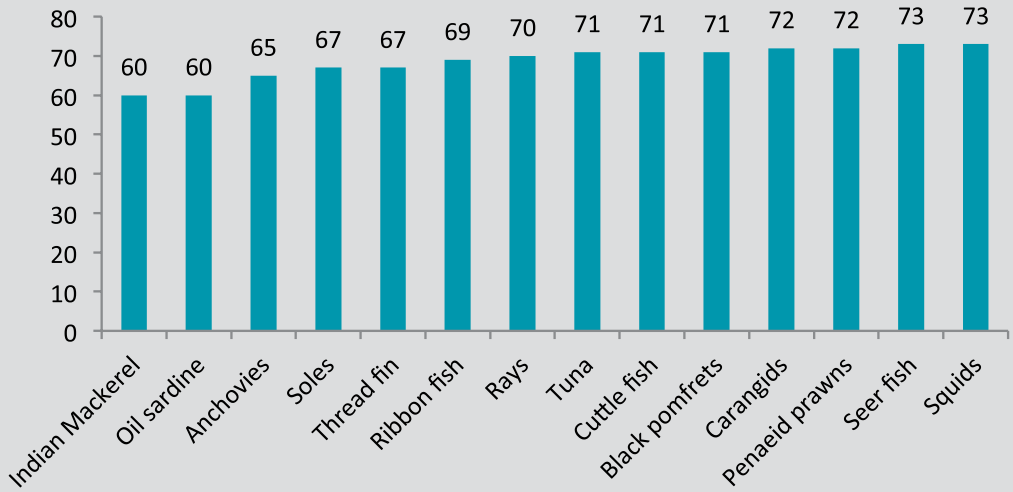
The average retail centre prices of important species across coastal states are indicated. Price range of black pomfret lies between ₹292 and ₹475, while that of oil sardine was between ₹23 (In Andhra Pradesh) and ₹95 (In Orissa).

Average Retail centre prices of important species- across coastal states

Species	GUJ	MAH	GOA	KNK	KER	TN	AP	ORS	WB
Oil Sardine	49	85	85	87	88	40	23	95	94
Indian Mackerel	128	190	190	218	161	184	83	190	198
Anchovies	89	125	90	134	136	217	70	145	89
Soles	94	121	120	151	110	96	40	135	125
Thread fin breams	85	152	110	95	165	176	51	160	158
Carangids	198	195	210	185	248	208	216	210	195
Rays	118	172	180	240	141	126	74	180	185
Tuna	158	210	172	155	182	164	155	210	280
Ribbon fish	125	125	170	149	208	131	53	180	160
Squids	195	210	230	154	214	213	150	260	240
Cuttle fish	198	185	215	147	185	176	150	260	285
Penaeid prawns	268	320	380	390	350	324	450	375	365
Seer fish	302	475	575	550	425	514	231	450	400
Black pomfrets	292	450	440	319	380	378	342	405	475

Fishermen share of consumers rupee

The fisher's share of consumer's rupee for the major species of market significance. The share ranges from 60% to 73%. The most profitable species for the fishermen include seer fish and squids.



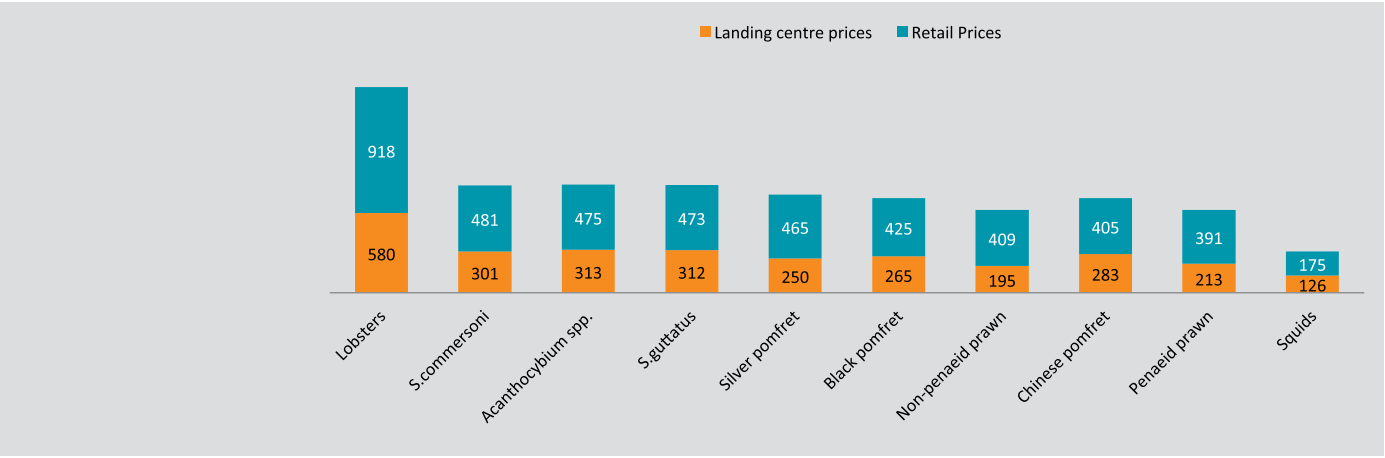
Fisherman's share of consumer's rupee– All India (Rs/kg)

Average fisherman's share of consumer's rupee of important species across coastal states.

Species	GUJ	MAH	GOA	KNK	KER	TN	AP	ORS	WB
Oil Sardine	45	65	54	51	51	53	78	68	74
Indian Mackerel	66	67	68	45	59	65	60	67	44
Anchovies	65	52	47	84	69	61	57	76	69
Soles	72	64	48	94	57	69	58	63	66
Thread fin breams	56	54	56	68	70	74	65	78	73
Carangids	68	86	72	76	63	72	58	83	72
Rays	78	73	61	68	64	73	65	75	73
Tuna	68	64	55	73	65	74	61	86	82
Ribbon fish	66	63	68	65	65	76	60	81	69
Squids	66	77	73	87	65	77	60	85	67
Cuttle fish	67	80	75	85	62	74	60	84	56
Penaeid prawns	75	79	65	82	63	76	57	73	81
Seer fish	64	61	59	85	73	76	64	83	86
Black pomfrets	61	80	64	85	76	76	60	78	63

Average Price realisation of high value fishes

The price realization of the high value species across the country is represented. The price ranges from ₹175 for squid to ₹918 for lobsters at the retail centres, while the landing centre prices range from ₹ 126 for squid to ₹580 for lobste₹ The lobsters are priced the highest.



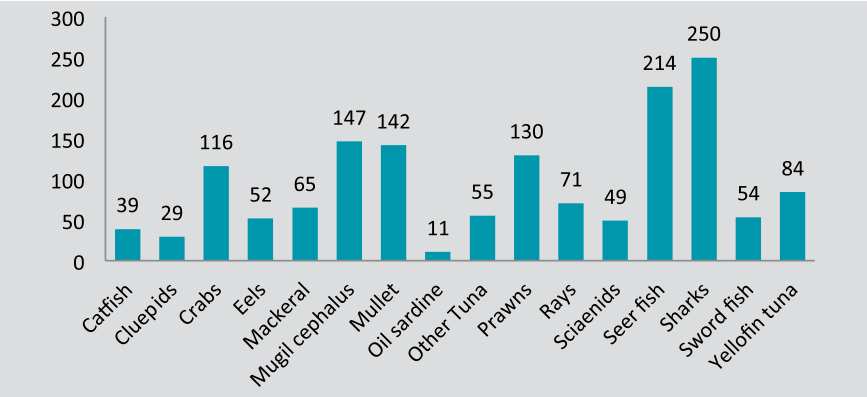
Average price realisation of high value species

II. Average fish price realisation across major landing centres

Andhra Pradesh

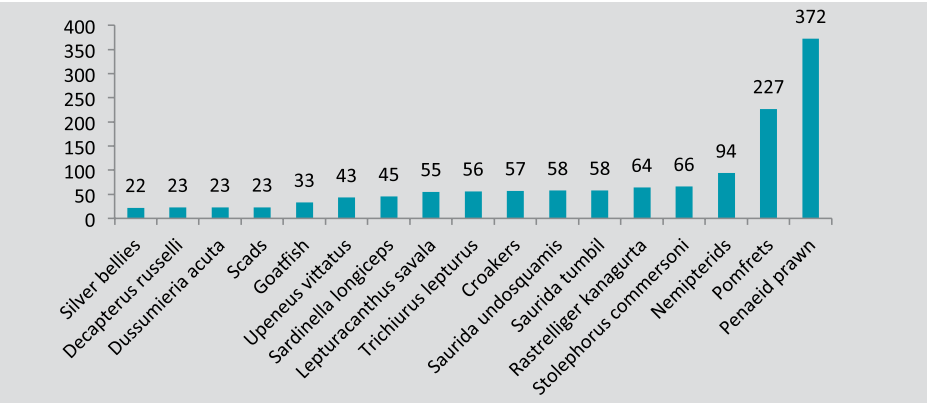
Average price of fish species in Dummulpeta landing centre is given. The price ranged from ₹11 to ₹250. Among the major fish species landed sharks

accounted for the highest average price of ₹ 250 per kg. The least average price of the fish species reported was oil sardine (₹11 Per kg).



Average price of fish species landed in Dummulapeta, Andhra Pradesh

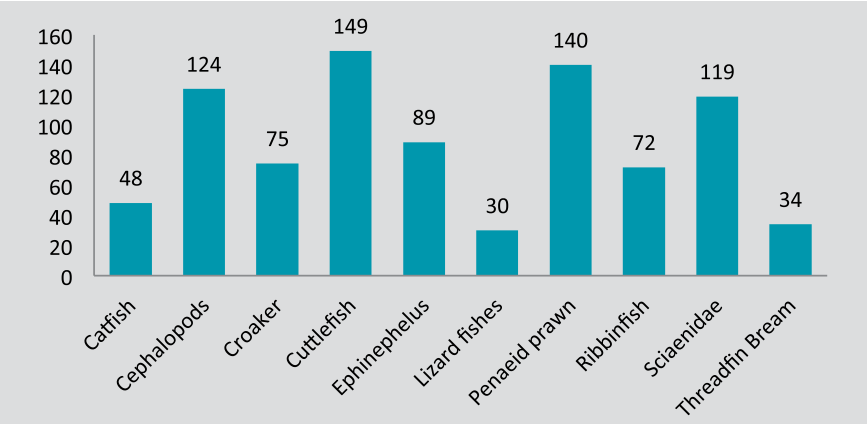
Average price of fish species in Vishakhapatnam landing centre is given. The price ranged from ₹22 to ₹372. Among the major fish species landed penaeid shrimp accounted for the highest average price. The least average price of the fish species was reported for silver bellies.



Average price of fish species landed in Visakhapatnam, Andhra Pradesh

Gujarat

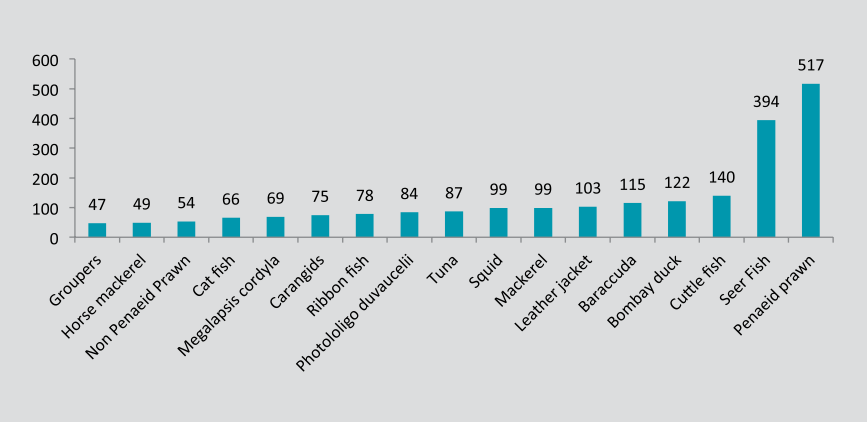
Average price of fish species in Veravel landing centre is given. The price ranged from ₹30 to ₹149. Among the major fish species landed Cuttlefish accounted for the highest average price with ₹149 per kg. The least average price of the fish species reported was Lizard fish.



Average price of fish species landed in Bhidiya, Veraval, Gujarat

Maharashtra

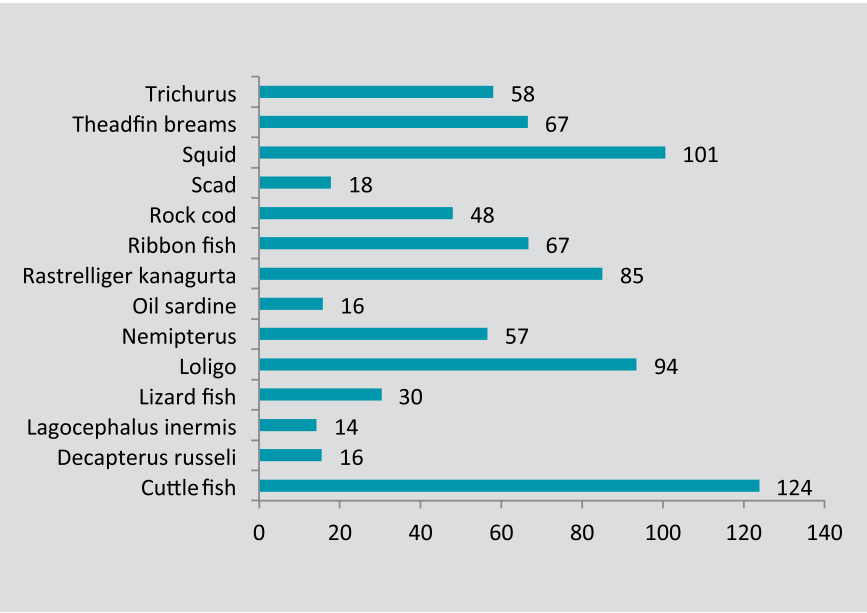
Average price of fish species in Sassoon Dock landing centre is given. The price ranged from ₹47 to ₹517. Among the major fish species landed penaeid shrimp accounted for the highest average price with ₹ 250 per kg. While the average price of groupers were found to be the least.



Average fish species landed in Sasson dock.

Karnataka

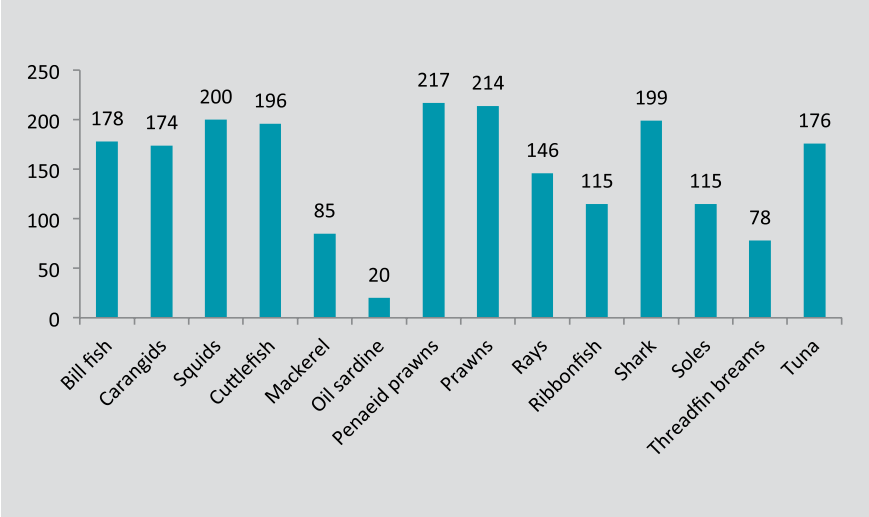
Average price of fish species in Mangalore landing centre is given. The price ranged from ₹14 to ₹124. Among the major fish species landed cuttle fish accounted for the highest average price with ₹ 124 per kg.



Average price of fish species landed in Mangalore, Karnataka

Kerala

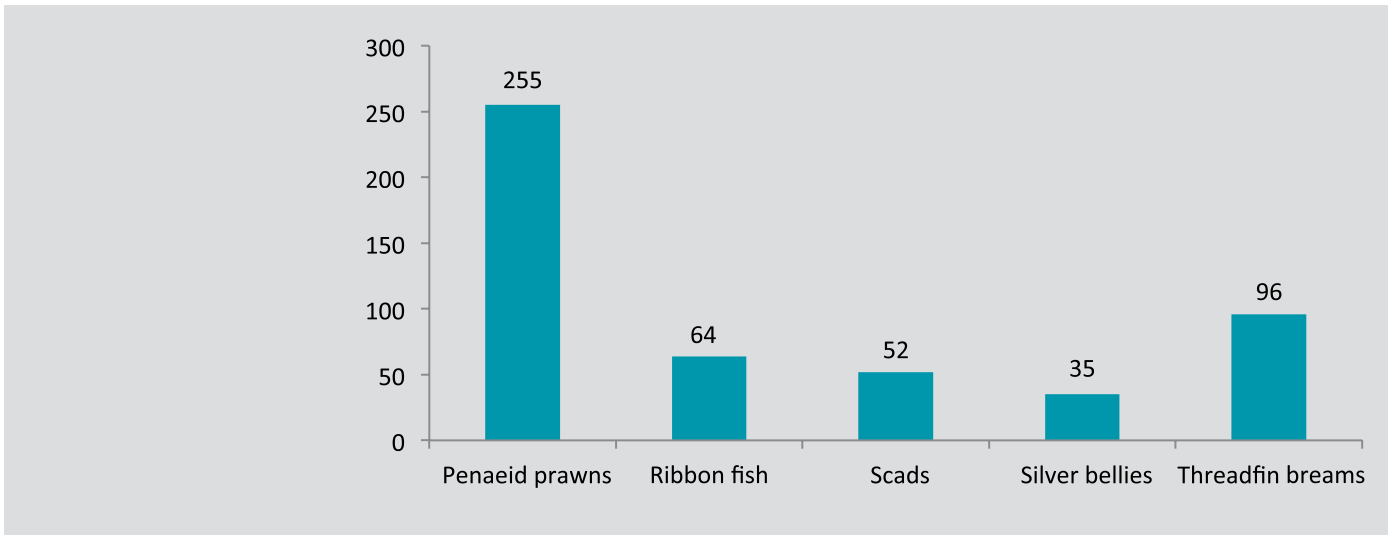
Average price of fish species in Cochin Fisheries Harbour is given. The prices ranged from ₹20 to ₹217. Among the major fish species landed penaeid shrimp accounted for the highest average price with ₹217 per kg. While the average price of oil sardines were found to be the least.



Average price of fish species landed in Cochin Fisheries Harbour, Kerala

Tamil Nadu

Average price of fish species in Chennai landing centre is given. The price ranged from ₹35 to ₹255. Among the major fish species landed penaeid prawns accounted for the highest average price with ₹255 per kg. While the average price of Silver bellies were found to be the least.

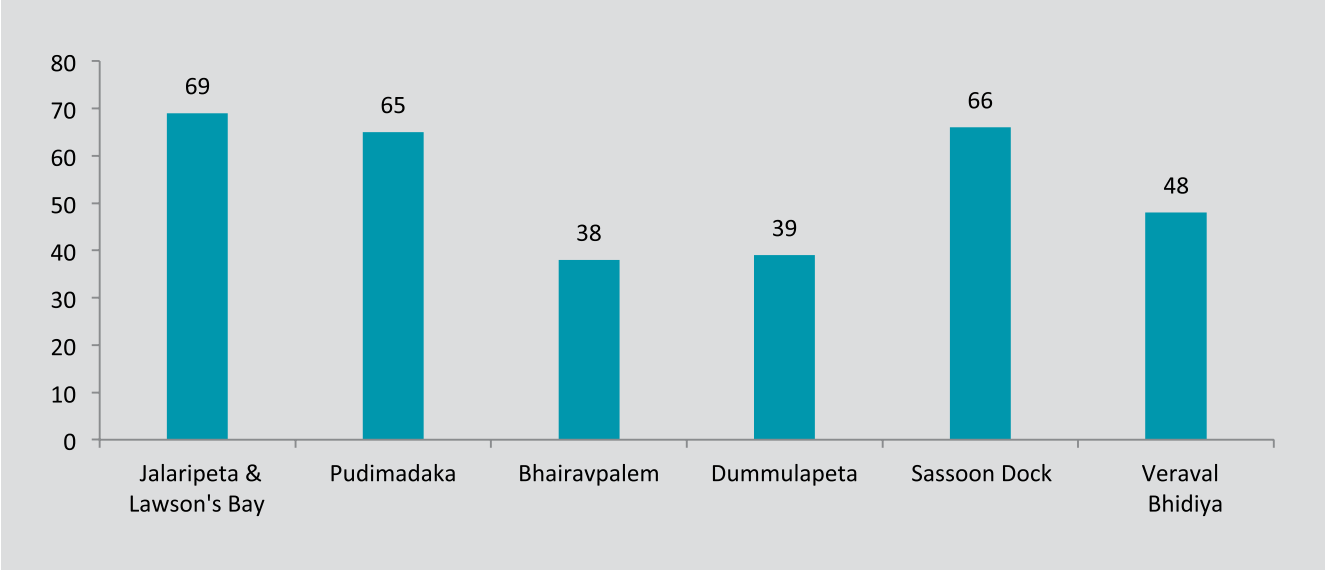


Average price of fish species landed in Chennai, Tamil Nadu

III. Average species wise fish price across different landing centres

Cat fish

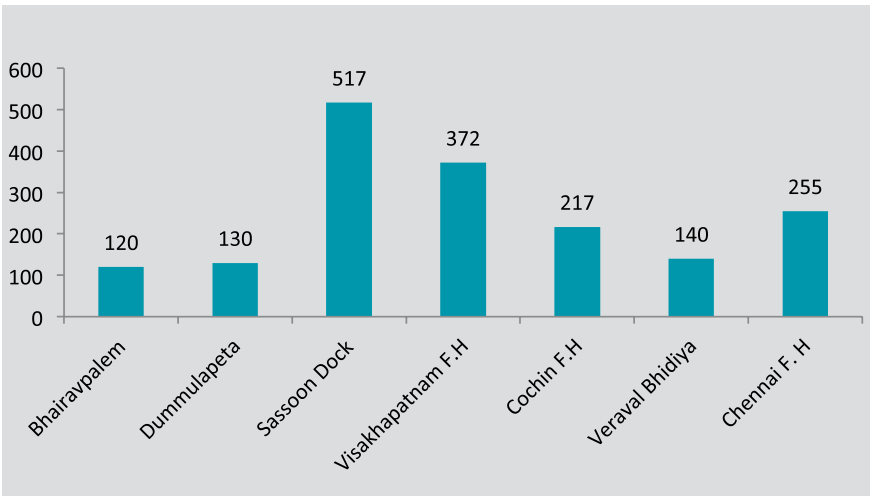
The average price of catfish across different landing centres is depicted. The price ranged from ₹38 to ₹69. The highest price of ₹69 per kg was at the Jalaripeta as well as Lawson's Bay of the Visakhapatnam landing centre of Andhra Pradesh, while the lowest price was at the Bhairavpalem in Andhra Pradesh.



Average price of catfish across different landing centres

Penaied prawns

The price range of penaeid shrimp across the different landing centres is shown. A maximum price of ₹517 was seen at the Sassoon Dock landing centre where as a minimum price of ₹120 was shown at the Bhairavpalem landing centre of Andhra Pradesh.



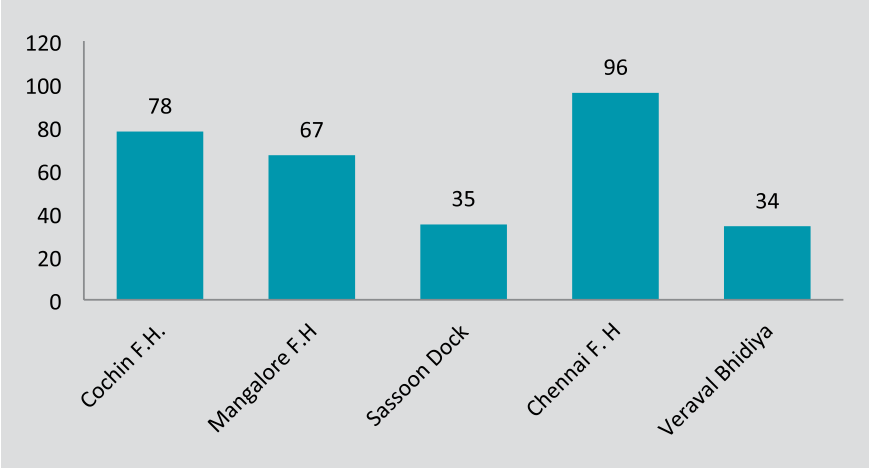
Average price of penaied prawn across different landing centres

Breams

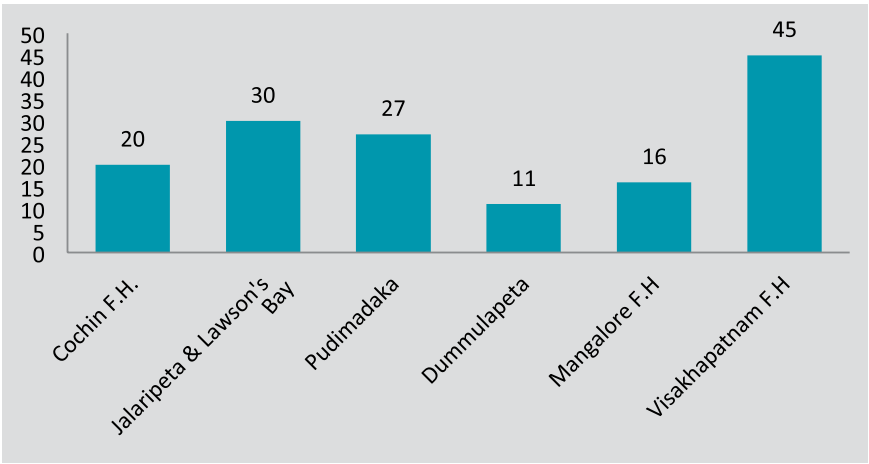
Illustrates the price of breams across different landing centres. The price ranged from ₹34 to ₹96, It was noted that the price of Breams were highest at Chennai fisheries harbour, while they were the least at Veraval Bhidiya.

Oil Sardine

The price range of Sardine across various landing centres is depicted. It varied from ₹11 to ₹45, highest price of ₹45 was found to be at Vishakapatanam harbour while the lowest price of ₹11 was at Dummulpeta landing centre.



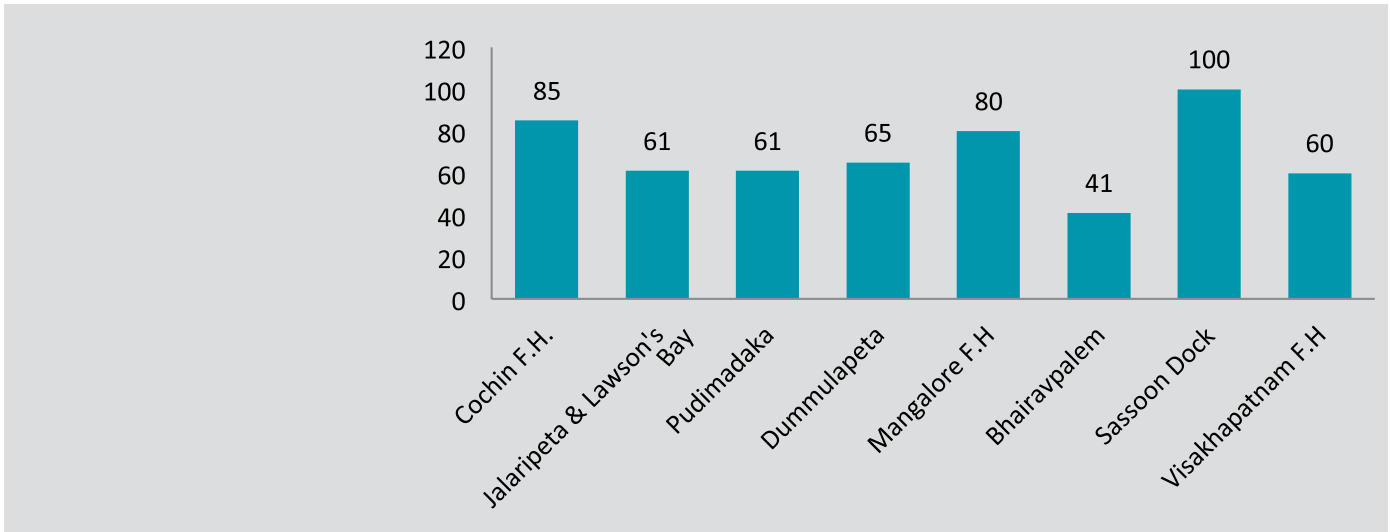
Average price of Breams across different landing centres



Average price of Sardine across different landing centres

Mackerel

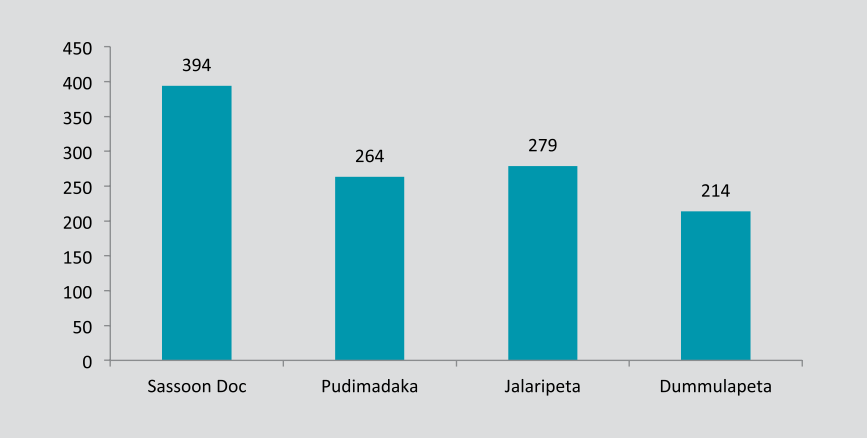
The price range of mackerel is shown. It ranged from ₹41 to ₹100. The price was highest in Sassoon Dock and the lowest at the Bhairavpalem landing centre.



Average price of mackerel across different landing centres

Seer fish

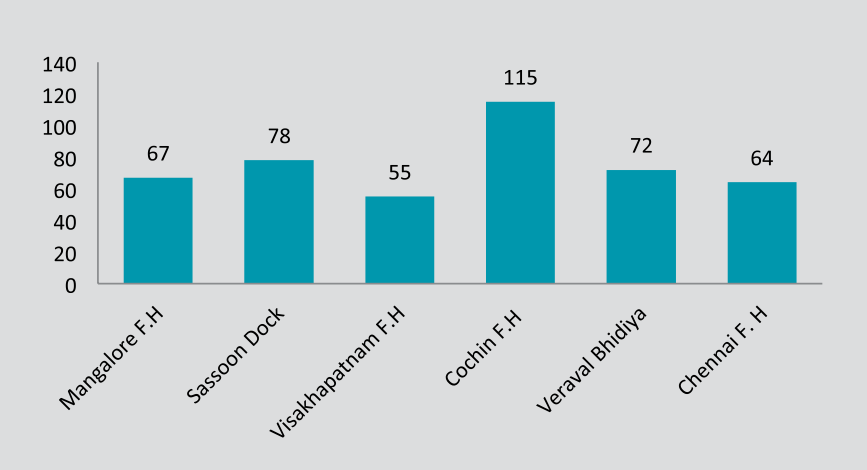
The price of seer fish across the various landing centres is shown. The price ranged from ₹214 to ₹394. The price was the highest at Sassoon Dock landing centre and least at the Dummulpeta landing centre.



Average price of seer fish across different landing centres

Ribbon fish

The price range of ribbon fish across the various landing centres is depicted. The price ranged from ₹55 to ₹115. It was the least at Vishakapatanam fisheries harbour and highest at the Cochin fisheries harbour.



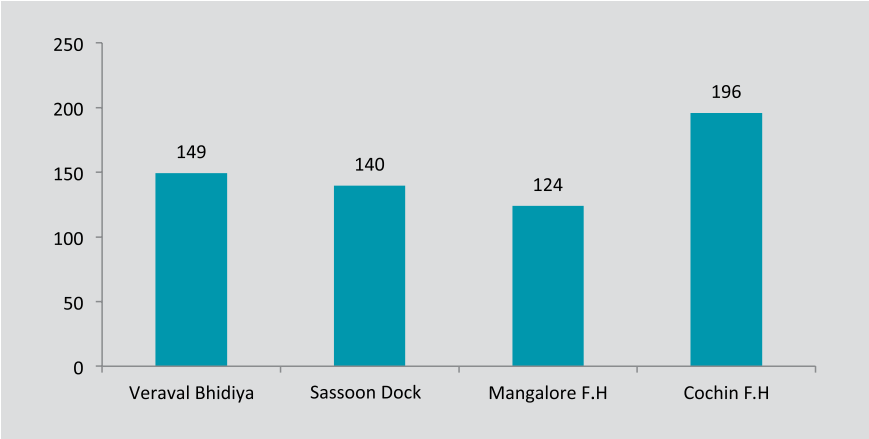
Average price of ribbonfish across different landing centres

Cuttle fish

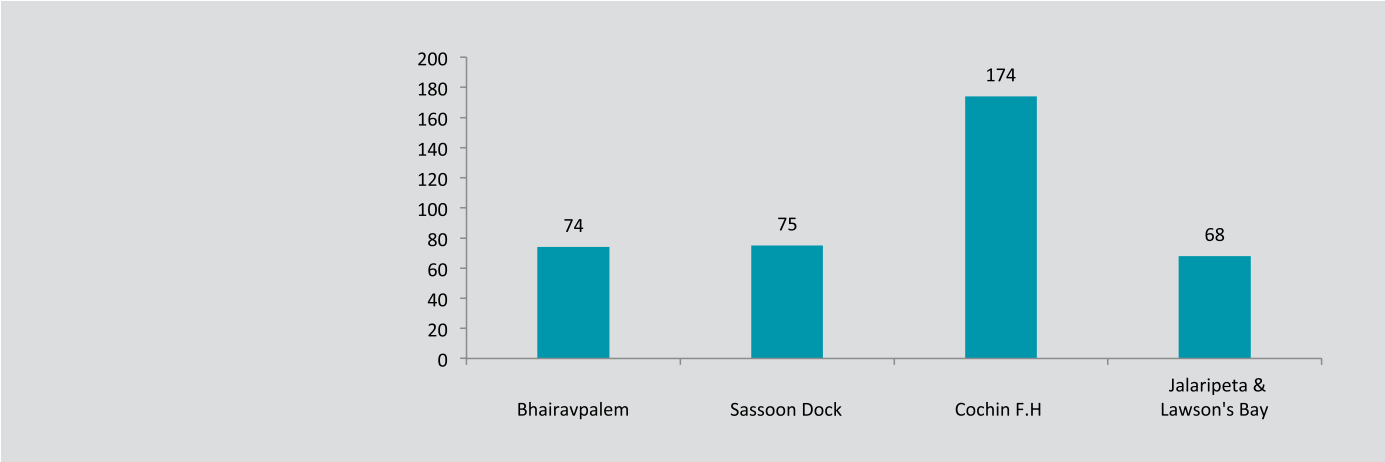
The price range of cuttlefish along the various landing centres is depicted. It ranged between ₹124 and ₹196. Cochin fisheries harbour showed the highest pricing while the lowest was at the Mangalore fisheries harbour.

Carangids

Depicts the price range of carangids across different landing centres, it shows at the price ranging from ₹ 68 at the Jalaripeta & Lawson's Bay, which is the least, and ₹174 at the Cochin fisheries harbour, which is the highest.



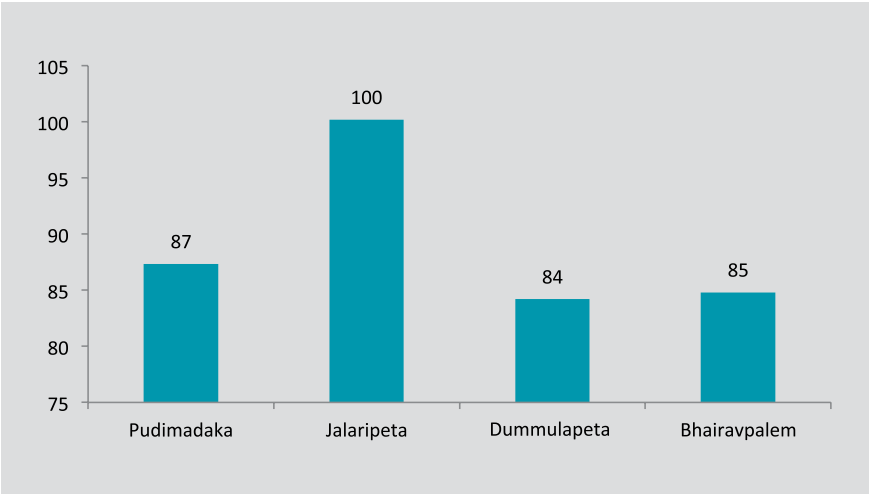
Average price of cuttlefish across different landing centres



Average price of Carangids across different landing centres

Yellowfin Tuna

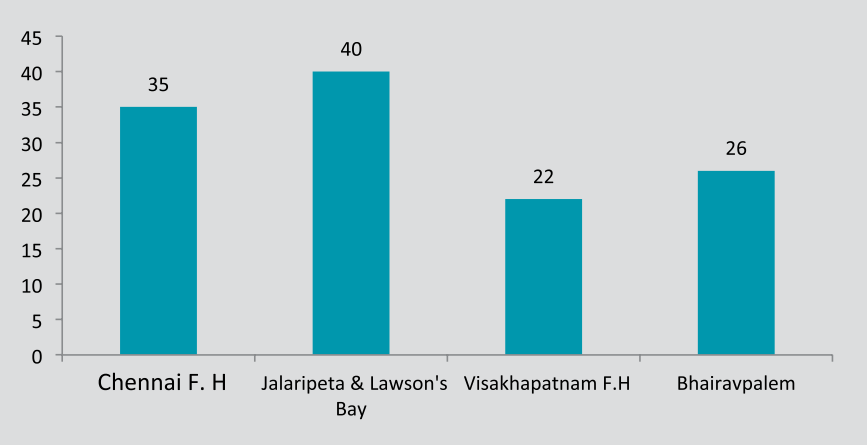
Depicts the price of yellowfin tuna across different landing centres. The price of Yellowfin tuna ranges from ₹84 to ₹100. It is highest at Jalaripeta and Lawson's Bay and least at Dummulpeta and Bhairavpalem landing centres.



Average price of Yellowfin tuna across different landing centres

Silver bellies

The price range of silver bellies across the various landing centres is show. The price ranged between ₹22 to ₹40. It was priced highest at Jalaripeta and Lawson's Bay and least at Vishakapatanam fisheries harbour.



Average price of silver bellies across different landing centres

Fish Market Grid

Research Project: FISHCMFRISIL201202000023

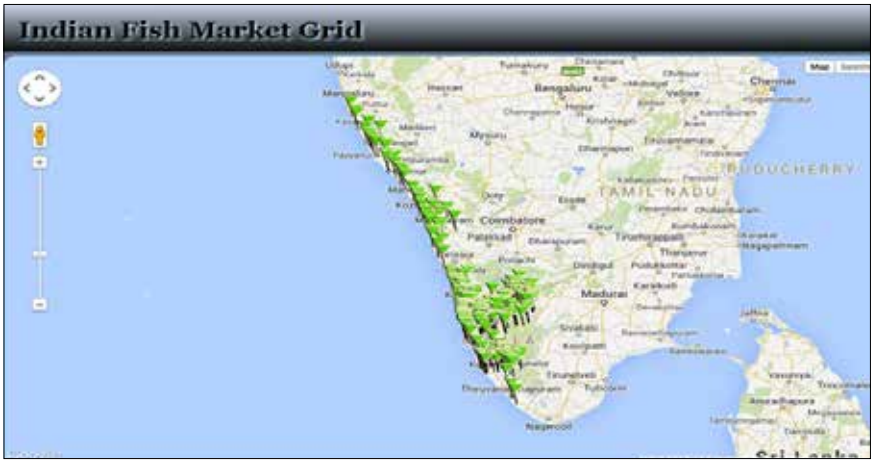
The market grid encompasses the different information related to the market structure which includes selected ten dimensions of location, access, timing, conduct, species, arrivals, disposals, adequacy, regulations, and intelligence. The ten dimensions of market structure of over 400 markets (wholesale/ retail) was covered in the coastal states of Kerala, Karnataka Tamil Nadu, Gujarat and Maharashtra for developing the fisheries grid. The outcome will provide the different stakeholders all the important information to identify best target market for disposal, determine fish arrivals, make rational buying decision, utilizing capacity and developing market regulation policies. The proposed market grid is given.

Indian fish market grid

Decision Support System

The fish market grid offers a decision support system which could be run query based across the states, districts and markets. The queries could be done for species and its availability, arrivals and disposals (Fig 29) .The query when provided leads to the display of the map layers of the fish market grid portraying the different markets relating to the query provided. (Fig 30). The output could be viewed with the suggested markets, prices and quantum available (Fig. 31).

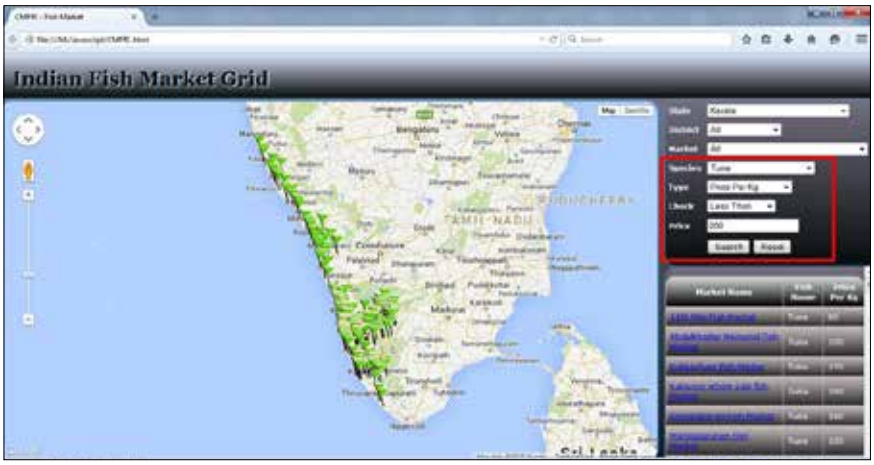
Decision Support System- Query



Decision Support System- Map Layer

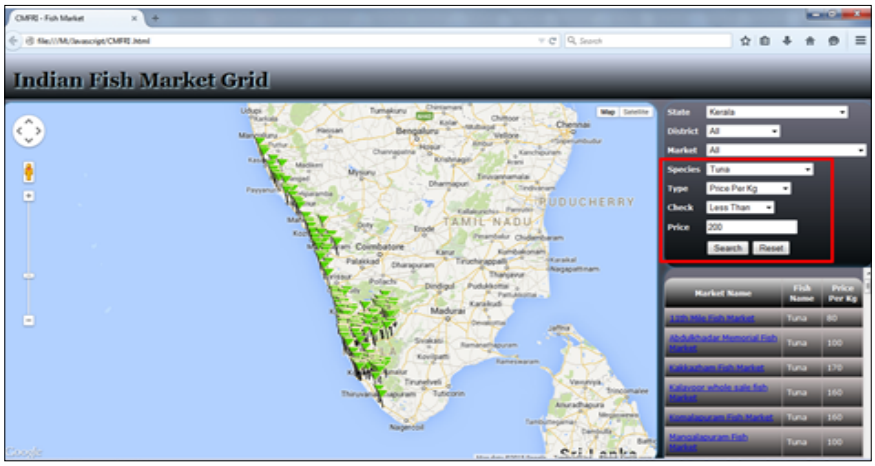
Decision Support System - Output

The Indian fish market grid with the query, map layers, and the generated output is given in Fig. 32.

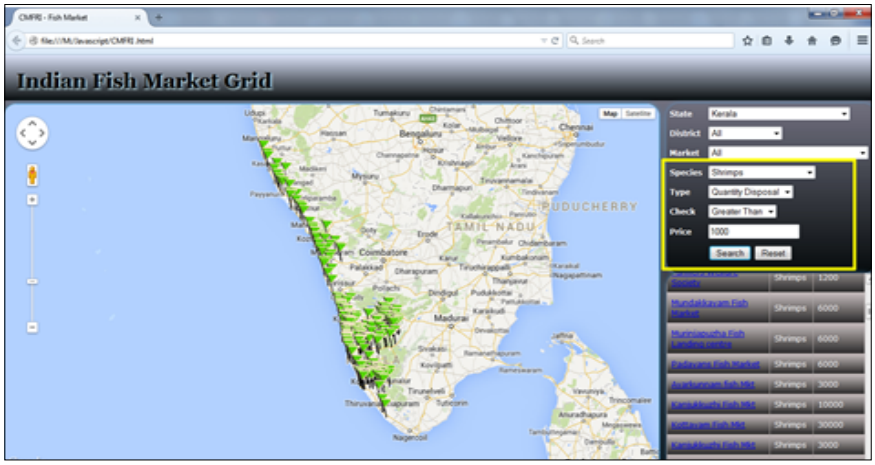


Indian fish market grid- Decision support sytem -Query , Map layers, and the generated output

A query based decision support system output generated for two species in the markets in Kerala is given in Fig. 33 and Fig. 34.



Query based decision support system output generated for Tuna



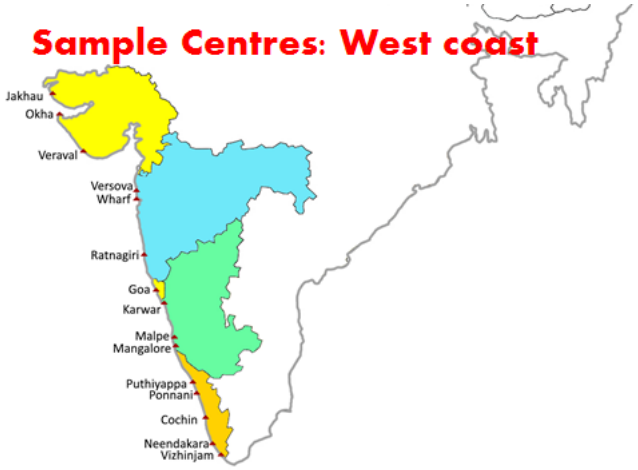
Query based decision support system output generated for Shrimps

A study on the Estimation of Input cost of Marine Fishery (including Prawns and High Valued Fish) for arriving at Gross Value Added (GVA)

Research project: EF-31/MOSPI-CSO

The National Accounts Division of Ministry of Statistics of Programme Implementation sanctioned the project entitled 'A study on the Estimation of Input cost of Marine Fishery' (including Prawns and HighValued Fish) for arriving at Gross Value Added (GVA) for the period from July 2014 to August 2015. The project involves estimating the input costs in the marine fishing sector and the revenue realised to arrive at Gross value added.

The objective of the study was to estimate the input use in the marine fishery sector state-wise to work out the Gross Value Added (GVA) in the sector'. The cost and returns per trip in marine fishing comprises mainly two major cost components. The first one is fixed costs and the second is operational costs and revenue. To collect information on these three components, three types of schedules were prepared for collecting data from the sample fishing



units. 1). Schedule to Collect operating cost and returns per trip from the sample fishing units on a continuous basis; 2)Schedule to collect fixed cost data and fishing pattern from mechanised fishing units as one time data collection; 3) Schedule to collect fixed cost data and fishing pattern from non-mechanised and motorized fishing units

The analysis of the economic performance indicated that the average input-output ratio ranged from 0.40 to 0.72 in the mechanised sector, 0.31 to 0.42 for motorized sector and around 0.11 to 0.22 for non-mechanised sector for the various craft-gear combinations. The average input-output ratio across the sectors worked out to 0.36. The average capital productivity was 0.63 at national level.

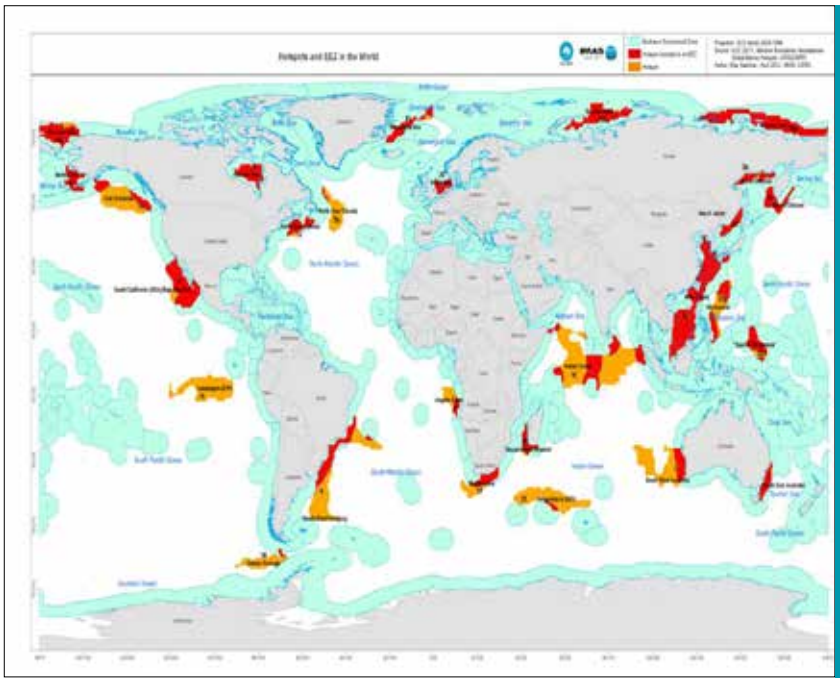
Global understanding and learning for local solutions: Reducing vulnerability of marine-dependent coastal communities (GULLS)

Research Project: EF-21/Gulls- 1004280

The CMFRI research project on "Global understanding and learning for local solutions: Reducing vulnerability of marine-dependent coastal communities" (GULLS) under the theme of Coastal Vulnerability was sanctioned under a MoU of Belmont Forum and G8 Research Councils International Opportunities Fund as a new scheme for a period of four years at a total cost of ₹ 1.54 crores.

Brief Description of the project

This project addresses the Belmont Challenge priorities in the area of coastal vulnerability - specifically the challenges that arise in food security and



Hemisphere hotspots

Ocean regions experiencing fast warming and those with heightened social tensions as a result of change

SouthAfrica

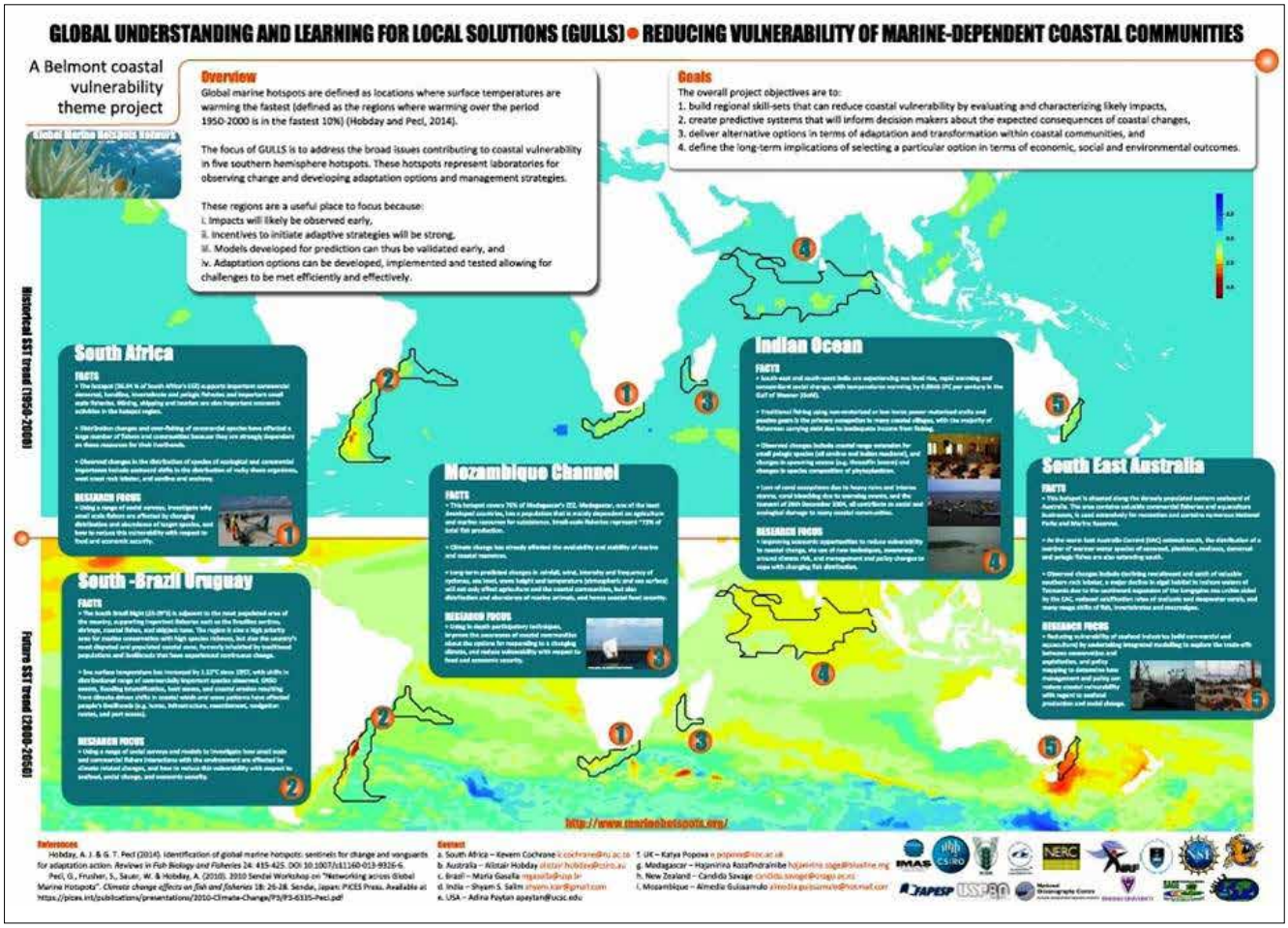
Southern Australia

Western Australia

Mozambique channel

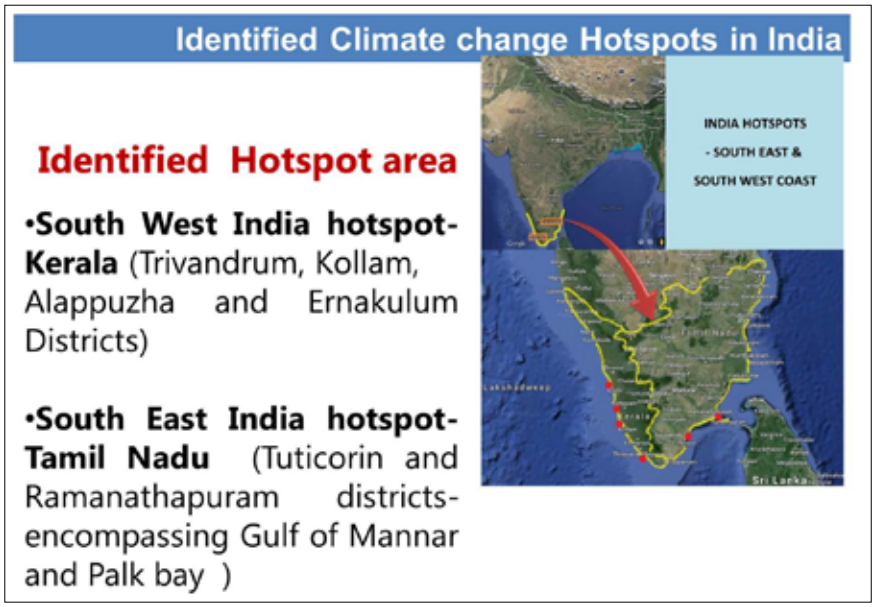
Southern India

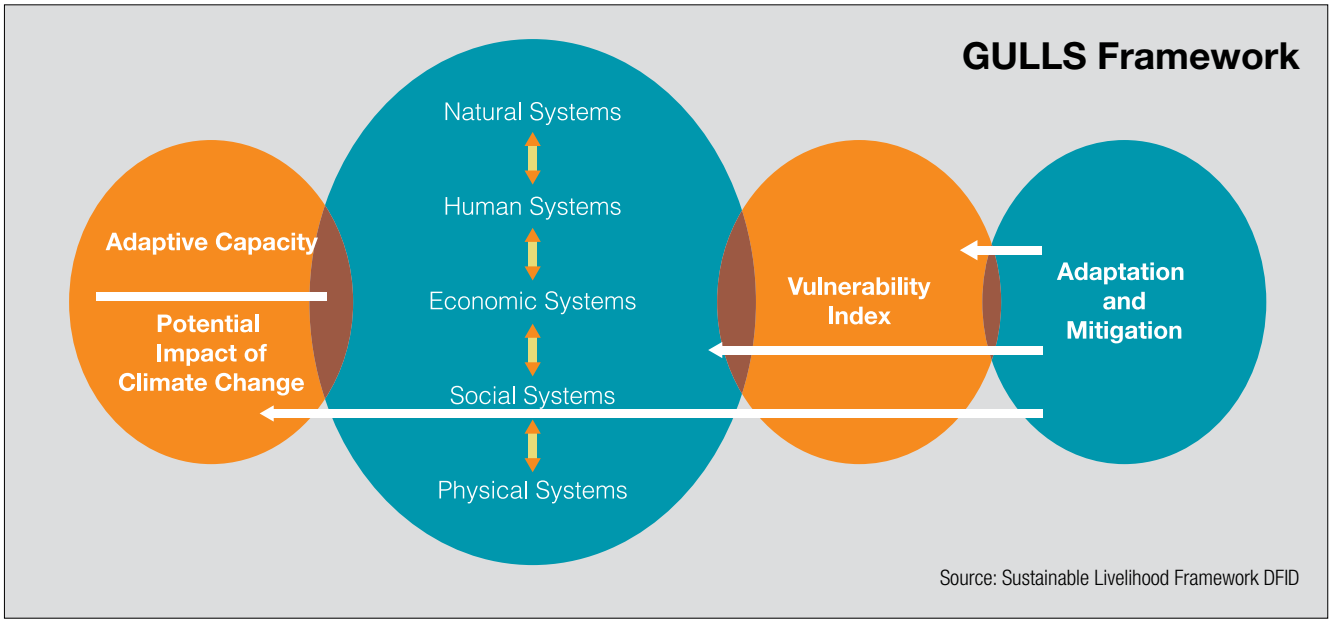
Brazil



sustaining coastal livelihoods as a result of global warming and increasing human coastal populations.

The project will contribute in improving community adaptation efforts by characterizing, assessing and predicting the future of coastal-marine food resources and identification of suitable adaptation options. The overall





project objectives is to build regional skill-sets that can reduce coastal vulnerability by evaluating and characterizing likely impacts, create predictive systems that will inform decision makers about the expected consequences of coastal changes; deliver alternative options in terms of adaptation and transformation within coastal communities; and to define the long-term implications of selecting a particular option in terms of economic, social and environmental outcomes.

The first workshop for developing uniform methodology for the comparative analyses of the observed natural and social changes across the different climate change hotspot regions, to select a common vulnerability assessment framework and to evaluate available system models for each region along with the different project partner institutions/ countries was organized during 1-5 April 2014 at Rhodes University, Grahamstown, South África. Each country's team presented their work plan and respective hotspot details in the workshop. Indian team made five presentations in the workshop on different topics including 'Team India Work Plan', 'Indian Fisheries Resources', 'South East India Hotspot', 'Vulnerability Assessment', 'Hot spot activities synthesis draft and responsibility allocation for planned work in India'. The workshop developed objectives and activity plan for the rest of the project period for respective hotspot area through discussions with the participants. Moreover a hot spot synthesis draft for the planned work for the project and responsibility allocation in the hotspot activities of CMFRI team was finalized in the workshop. The identified climate change hotspots selected for the project is given.

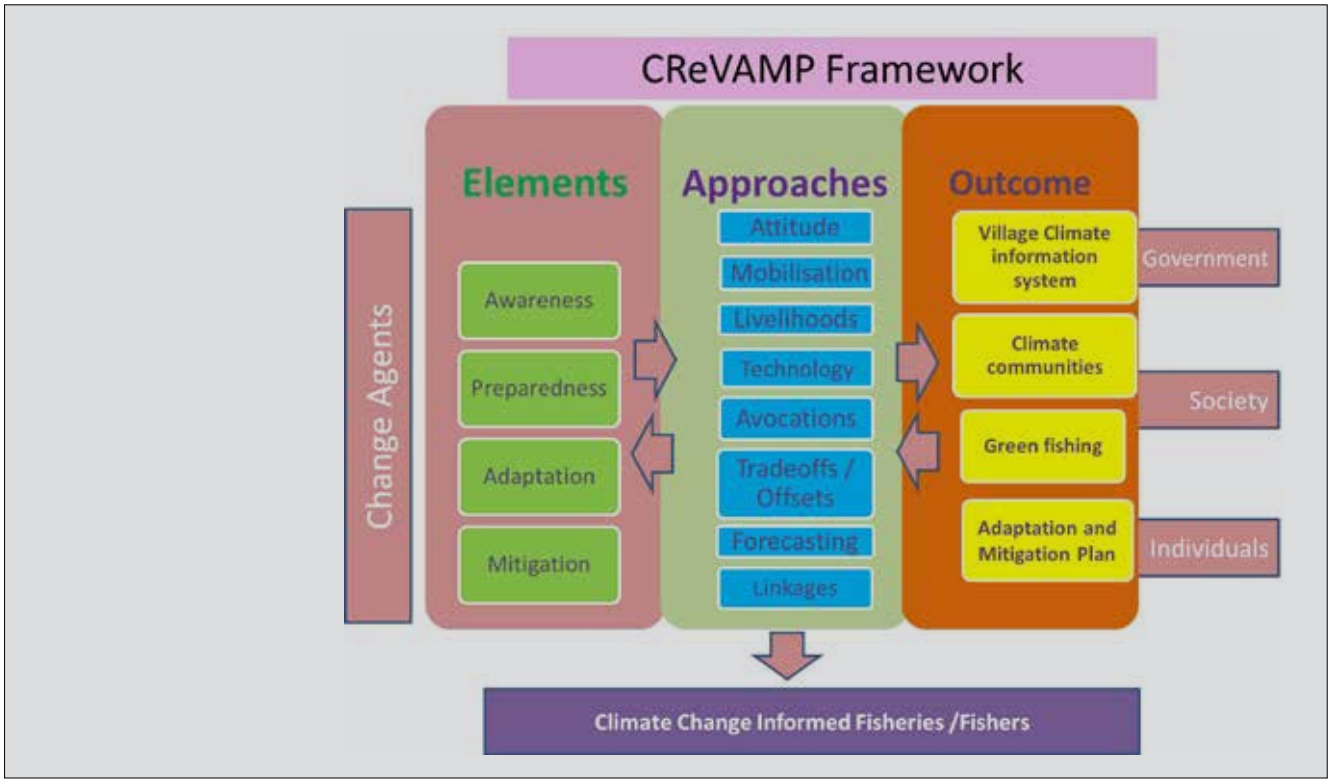
Assessment of climate change awareness level of local fisher folk in Kerala.

Narrakkal and Ochanthuruth fishing villages of Ernakulam district were selected for the study based on the ranking the various coastal villages of the districts in terms of various socio economic parameter₹ The data were collected using a pre-structured schedule entitled Climate Change Awareness Questionnaire (CCAQ) which was administered on a sample of 300 respondents.

Household Vulnerability survey (Ernakulam& Thiruvananthapuram district)

A uniform "Fishers household vulnerability survey schedule" was finalized after discussion with the international project (social team) team member₹ Pilot testing of 40 households was carried out in Elamkunnapuzha Grama Panchayat, the highest vulnerable fishing village in Ernakulum District and the schedules were modified accordingly. The survey was carried out covering 300 households in the study area.

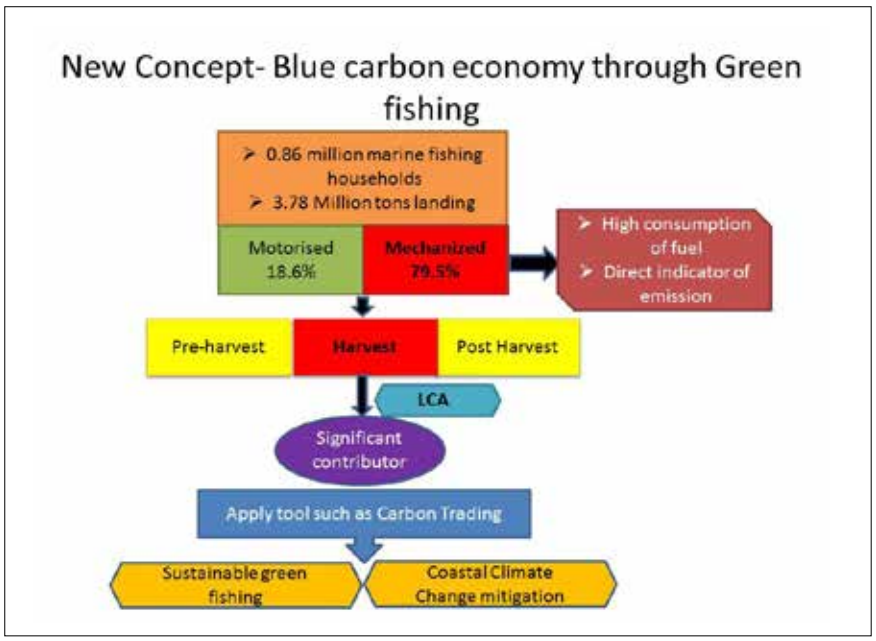
Climate change vulnerability assessment such sensitivity, adaptive capacity, resource management, exposure, adaptive options, community infrastructure, attitude and perception of primary stakeholders was carried out at Poonthura and Beemapally fishing villages of Thriuvanathapuram district (600 households).



The data collection was done through local enumerators from the community; mostly literate women and college students after an enumerator training workshop. The data obtained was tabulated and analysed. Along with this CReVAMP (Climate Resilient Village Adaptation and Mitigation Plan) framework was developed and linkages across departments / LSGs were established.

Carbon estimation using Life Cycle Assessment as a tool

Computed carbon emissions across the value chain of marine fisheries, inclusive of pre-harvest, harvest and post-harvest stages employing LCA. This study would help in identifying the sector of fisheries which emits carbon significantly.

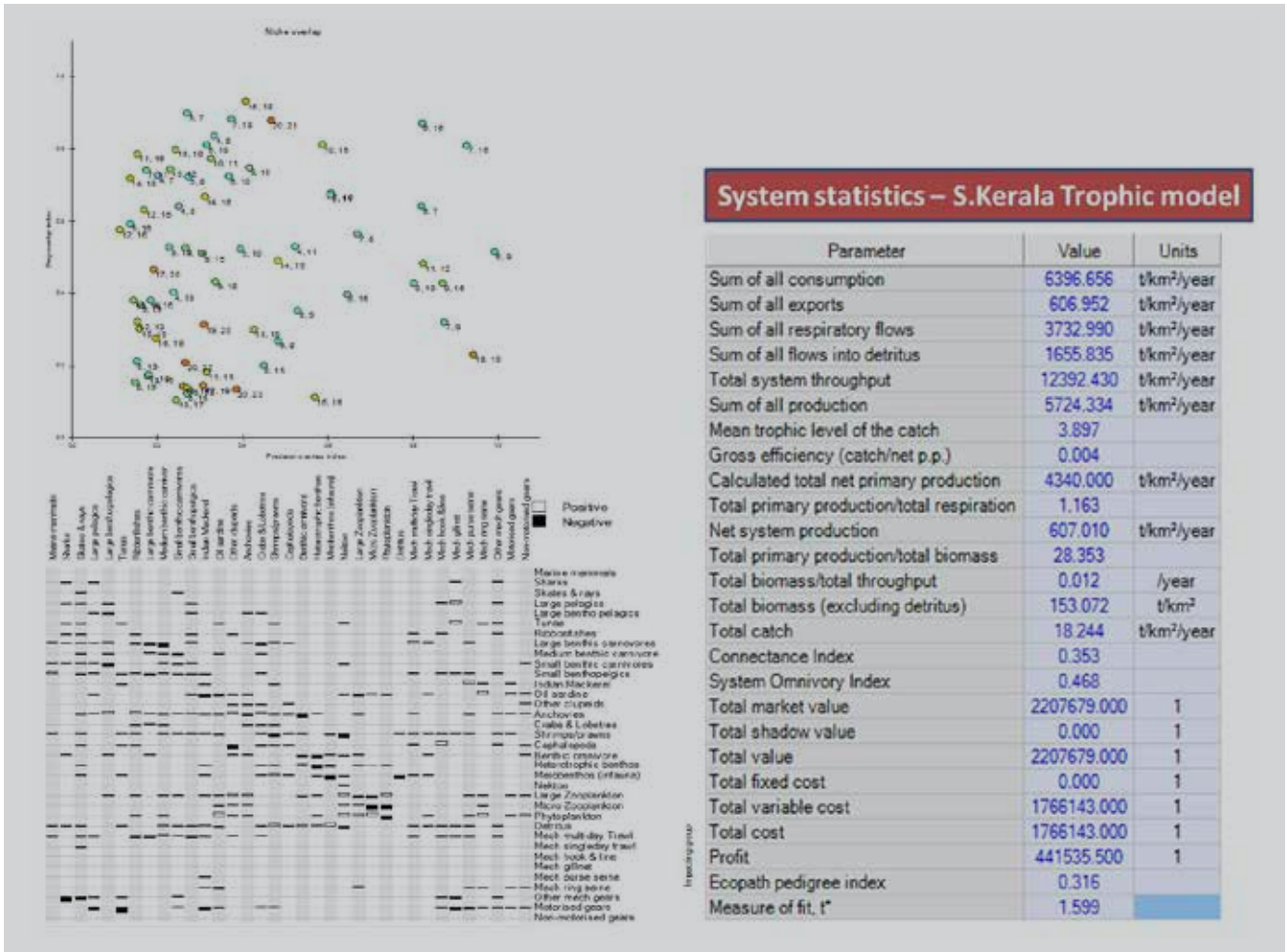


Trophic modelling of South Kerala ecosystem

Trophic modelling is meant to build a trophic mass balance model of marine ecosystems of Southern Kerala, using ECOPATH software, which incorporates energy flows between the trophic levels and interactions among the trophic components. The coastal districts of Kerala including Trivandrum, Kollam, Alappuzha and Ernakulum were considered for analysis. Total habitat area of 18,059 Km^2.

Analyzed gearwise fishery landings of South Kerala for the period 2001 -2013.

The components of Ecopath model include 26 groups which include marine mammals, sharks, skates & rays, large pelagics, large benthopelagics, tunas, ribbonfishes, large benthic carniovores, medium benthic carnivore, small benthic carnivores, small benthopelgics, Indian mackerel, oil sardine,



System statistics – S.Kerala Trophic model

Parameter	Value	Units
Sum of all consumption	6396.656	t/km²/year
Sum of all exports	606.952	t/km²/year
Sum of all respiratory flows	3732.990	t/km²/year
Sum of all flows into detritus	1655.835	t/km²/year
Total system throughput	12392.430	t/km²/year
Sum of all production	5724.334	t/km²/year
Mean trophic level of the catch	3.897	
Gross efficiency (catch/net p.p.)	0.004	
Calculated total net primary production	4340.000	t/km²/year
Total primary production/total respiration	1.163	
Net system production	607.010	t/km²/year
Total primary production/total biomass	28.353	
Total biomass/total throughput	0.012	/year
Total biomass (excluding detritus)	153.072	t/km²
Total catch	18.244	t/km²/year
Connectance Index	0.353	
System Omnivory Index	0.468	
Total market value	2207679.000	1
Total shadow value	0.000	1
Total value	2207679.000	1
Total fixed cost	0.000	1
Total variable cost	1766143.000	1
Total cost	1766143.000	1
Profit	441535.500	1
Ecopath pedigree index	0.316	
Measure of fit, t*	1.599	

other clupeids, anchovies, crabs & lobsters, shrimps/prawns, cephalopods, benthic omnivores, heterotrophic benthos, meiobenthos (in fauna) nekton, large zooplankton, micro zooplankton, phytoplankton and detritus.

Estimated the biomass, production/ biomass (P/B) ratio, consumption/ biomass (Q/B) ratio and diet matrix of 26 groups.

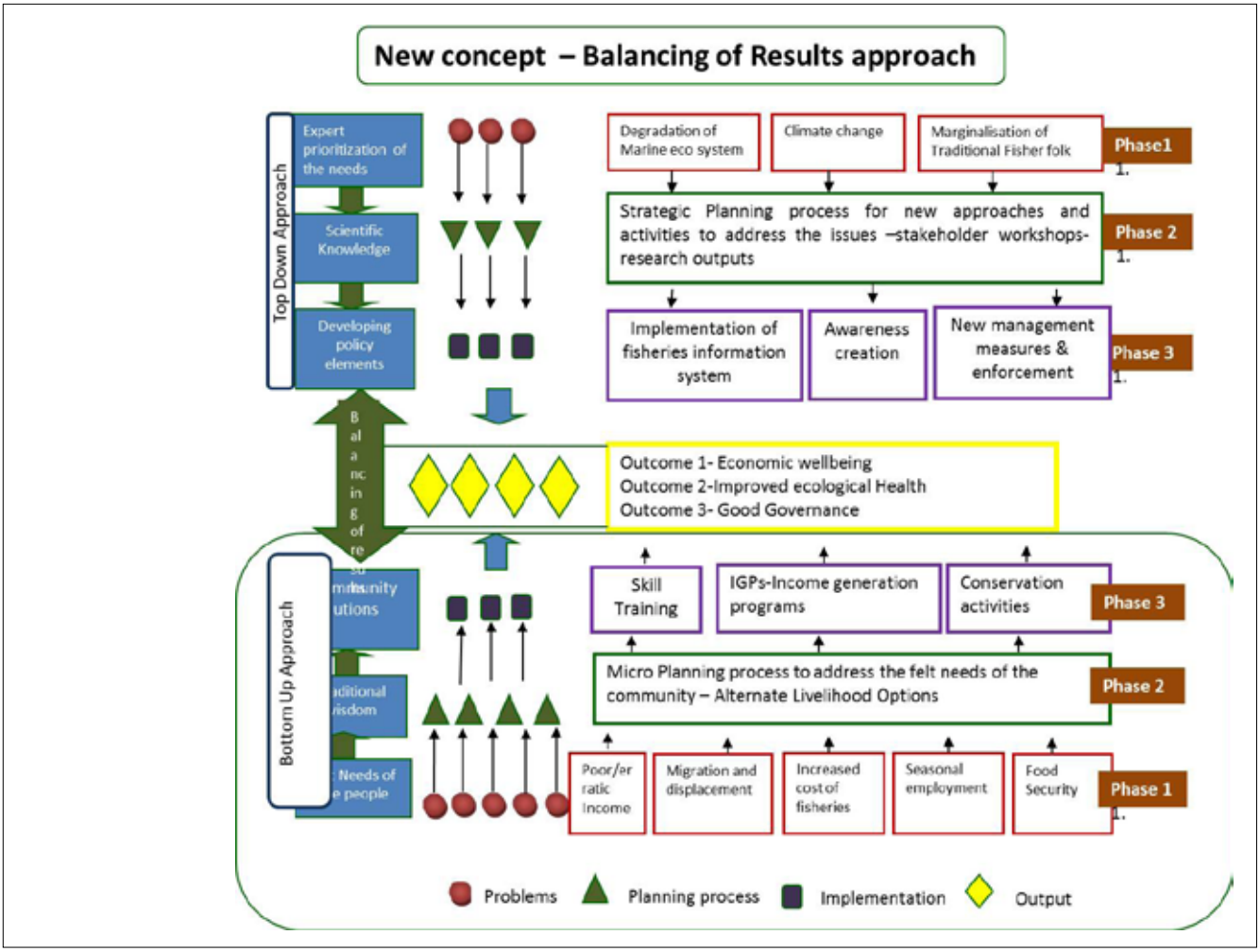
The model was mass balanced.

Development of common policy and governance framework

The three main ideas of governance centralized system(top down) decentralised (bottom up) and co management.

Inception, Awareness and training workshop

The project inception cum training workshop was held in Poonthura, Thiruvananthapuram. This was conducted in collaboration with Trivandrum Corporation and Department of Fisheries, Trivandrum on 25 February 2015.



The identified enumerators were trained in the collection of data for the global common schedule, which was jointly prepared by the participating countries. Pilot field training was provided to the selected enumerators to get hands on experience on the surveying techniques.

The project inception cum awareness workshop was held at Elamkunnapuzha on 22 April 2015 to give climate change awareness for the fisher community and to build community platform for implementing the project activities within the Panchayath. The target population included women, experienced fishers and children.

FISHERY GOVERNANCE, LIVELIHOOD, GENDER AND WELFARE

Capacity development for ecosystem based responsible fisheries management (EBFRM) in India - A co-learning action research

Research Project: FISHCMFRISIL20120200022

Identification and prioritization of EBRFM entry points

In order to find out the EBRFM entry points and subsequent prioritization, both the steps which were conceptualized as a pre-requisite for designing the communication tools as well as strategies, co-learning sessions (Fig.1) were conducted in different locations in all the study states of Kerala, Tamil Nadu and Karnataka. Since stakeholders belong to different socio economic as well as technological categories (like traditional, motorized, and mechanized sectors which are conventional categories) a protocol was developed and it was used for keeping the discussions focused. Article 12 of the new guideline being developed by FAO for small scale fisheries was also used to characterize capacity development in the context of small scale fisheries.

Based on the outcomes of the various co-learning sessions capacity deficiency matrices were prepared. These matrices were subjected to content analysis to deduce the EBRFM entry points. Table 1 depicts the prioritization ranking given by the respondents belonging to fisherfolk as well as the line departments in the states of Kerala, Karnataka and Tamil Nadu. Those entry points which got less than four stars will not be considered for the communication tools designing stage.

Perception on EBRFM entry points (stars indicating intensity or preferred priority) by respondents from fisherfolk and line departments

EBRFM entry points	Kerala	Karnataka	Tamil Nadu
Ecosystem Knowledge	*********	*****	********
Ecosystem based Fisheries Management	**********	*******	*********
Conservation measures	********	*******	*******
Regulations and Law	**********	********	********

Economics for management	****	***	*****
International instruments	******	****	*****
Rights based approaches	*****	*****	******
Gender sensitization	*****	**	******
Traditional knowledge	*****	*****	*****
Resource augmentation	*******	*****	******
On board best practices	*****	******	******
Sea safety	*****	*****	******
Group dynamics	****	******	****
Conflict resolution	***	****	*********
Participatory approaches	******	******	********
Computer literacy	*********	***	******
Green technologies	******	***	******
Value chain adaptations	*****	*******	******
Climate change preparedness	*****	*****	*****
Career guidance for students	******	*******	******
Health and hygiene advice	*****	**	******
Data sharing	***	**	***
Stock assessment science	******	**	******
Taxonomy	*****	**	*****
Bio diversity issues	***	*****	***

Major learning points from the co-learning workshops are summarized below:

1. ICT tools have good penetration among fisherfolk especially mobile phony. But effectiveness of such platforms in creating an EBRFM oriented Eco-literacy among the fisherfolk was perceived to be doubtful as such platforms do not provide opportunities for dialogue. Communication strategies that emphasize direct experience rather than contrived experiences need to be probed.
2. Convergence of individual perspectives into a “bigger picture” of what is happening in the commons should be the objective of any communication interventions. Community based dialogues on resource status, rent realisation, regulatory compliance and reinvention could be kindled using smart communication tools and strategies.
3. The epiphany that the research and management systems are running parallel need to be given serious epistemological attention.
4. There are pull signals from at least certain pockets where fisherfolk themselves demand interventions from the State. These ecological hotspots need to be targeted to frontline communication interventions.
5. Peculiarities of a Common property regime will act as noise in individual oriented capacity development interventions.

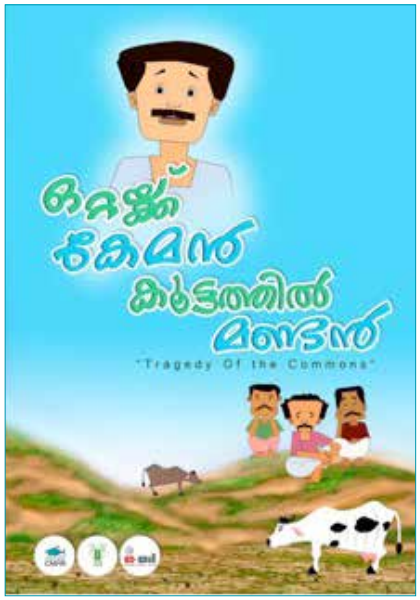
Capacity deficiency in the Research System

An attempt was made to identify capacity deficiency pathways in the Research system. CMFRI was taken as the candidate for analysis. Based on discussion with scientists of the research divisions the Research Communication pathway for the institute was constructed. Further discussions among experts led to the identification of major gaps in the pathway. (Fig.1)

It can be seen that there exists major epistemological and ontological disconnects in the research trajectory. Taking cognizance to the mandate of the institute the avowed objective of the research system represented by CMFRI is to come out with Fisheries Management Advisories (FMA) to the Government and Mariculture Technologies (MCT) for the fisherfolk. When the knowledge or technology generation pathways are subjected to research trajectory analysis it can be seen that the pathway leading to FMAs is devoid of two important steps. But those leading to the MCTs, lack only one step. In the case of FMAs synthesis of the knowledge inputs given by the respective research divisions is found to be lacking. The subsequent step of subjecting this synthesized knowledge to evaluations is also obviously missing. An evaluative step may not be logistically always possible in the context of natural resource management in an oceanic/aquatic context. But the multidivisional synthesis cannot be abrogated. Evaluation need not be post hoc and could be futuristic envisioning of "if not" scenarios. It could be this lacuna that gives the FMAs a namesake treatment from the receive₹

Animation Film on the Theme Tragedy of the Commons

An animation film titled *Ottakku Keman Koottathil Mandan* based on the metaphor of "tragedy of the commons" was designed and validated through the participatory media development process. The film (Fig. 2) running into 2.43 minutes has been conceptualised as a capacity development tool to initiate discussion on the issues of fisheries management among the fisherfolk. As this is a discussion tool, a supplementary "how to use guide for the communicator" also has been developed. Centre for Development of imaging Technology (CDiT), Thiruvananthapuram rendered the technical help in the animation.



Animation film developed under the project

Co-learning sessions on responsible fisheries management

Gender Mainstreaming and Impact of Self Help Groups (SHGs) in Marine Fisheries Sector

Research Project: FISHCMFRISIL201400300035

To study the impact of 'Self Help Groups' in gender mainstreaming, situational analysis was undertaken through participatory Learning and Action (PLA) in the selected potential maritime locations in Kerala, Karnataka and Tamil Nadu and identified SHGs with fishery based micro enterprises on the areas such as capture fisheries (Men SHGs), culture fisheries: bivalve farming, mussel culture and oyster farming, integrated finfish culture, cage culture, clam collection, ornamental fish culture, fish feed production, paddy-cum fish culture, processing and allied sector micro enterprises, (value added fish processing units, fish pickling), dry fish units, ready to eat fish products, ready to cook fish products etc.

For data collection, 4 types of standardized data collecting protocols have been developed for studying the impact of SHGs in gender mainstreaming in marine fisheries sector which covered general socio economics, gender analysis, assessment of level of performance and computation of empowerment index and elucidation of case study of SHG. Also developed the scales and indices for measuring the 'Level of Performance' and 'Empowerment Index' for the assessment of extent of empowerment of the selected SHGs though appropriate scale development procedures. The schedules were pre-tested in Mararikkulam, Thannermukkam, Kumarakom, Vadakkekkara, Vallikkunnu and Kasaba in Kerala, Bengare, Surathkal and Ullala villages of Dakshina Kannada district in Karnataka and Pamban, Rameswaram, Thankachimadam and Mandapam locations in Tamil Nadu and Arakuda and Astaranga villages in Puri district of Odisha for standardization.

Immanuel SHG, Capture Fisheries, Mararikkulam, Kerala

Assessment of the level of performance and empowerment index of 100 SHGs and documentation of the success cases of entrepreneurial capacity building of SHGs with special reference to gender perspective and video documentation for developing the cyber extension multimedia for gender mainstreaming and entrepreneurial capacity building in marine fisheries sector in Kerala, Karnataka, Tamil Nadu and Odisha has been undertaken. The different enterprises, locations and number of SHGs selected are presented in the Table.

Details of SHGs selected for the study

Micro enterprise	Location	No.of SHGs
Capture Fisheries (Men SHGs)	Mararikkulam, Kumarakom & Kasargod	5
Culture Fisheries: Bivalve farming : Mussel culture	Padanna, Vallikkunnu, Dhalavapuram	6
Oyster farming	Padanna, Moothakunnam & Kadalundi	6
Integrated finfish culture	Elamkunnappuzha, Thanneermukkam	3
Cage culture	Thanneermukkam, Thekkumbhagam,	3
Clam collection, Clam sale	Muhamma, Kayippuram, Thannermukkam	3
Ornamental fish culture & Vegetable farming	Narakkal, Chombal	2
Shrimp culture	Kandakkadavu, Thuravur,	2
Fish feed production	Chellanum, Ezhikkara, Kaitharam	3
Paddy-cum fish culture	Kumarakam, Thanneermukkam	3
Fish Fertilizer Producing Unit	Chavakkad	1
Processing & allied sector micro enterprises Value added fish processing units	Narakkal, Moothakunnam , Kumarakom	3
Fish pickling	Narakkal, Thekkumbhagam	2
Ready to eat fish products	Elamkunnappuzha, Vadakkekkara, Satar island, Vallikkunnu	4
Ready to cook fish products	Malappuram, Kollam, Azheekkode, Kannur	4
Dry Fish Units	Mararikkulam, Narakkal, Kottikkulam, Chellanum, Pampan, Mandapam	15
Sea weed culture	Pampan,Rameswaram, Thankachimadam, Mandapam (Tamil Nadu)	10
Dry fish units & Fresh Fish Procuring	Bengare, Surathkal, Ullala (Karnataka)	10
Fishing, Prawn seed collection, Bivalve collection	Arakuda and Astranga (Odisha)	15
	Total	100

Economic evaluation of Seasonal Fishing Ban (SFB) (Consultancy Project)

The value of the capital of exploitable stock has increased over the years substantially contributed by the regulation of fishing through SFB-both at national and in the selected maritime States. The annual growth rates of the resource groups (small pelagics, large pelagics, demersal) have shown a positive trend in the post-ban period significantly in the selected maritime States. The growth rate of motorized landings was higher in the post-ban period in the States of Gujarat, Karnataka and Andhra Pradesh.

In Andhra Pradesh, bio-diversity index worked out to assess the health of ecosystem (due to SFB) indicated that species diversity index increased

Jaivasree SHG, Fertifish production, Chavakkad, Kerala

steadily and now decreasing indicating stress between 1985 and 2013. Species diversity is highest in an intermediate level of disturbance in the ecosystem (2007-11) and then declined.

In Kerala, the total transaction cost for enforcement of SFB worked out to ₹248.14 lakhs out of which the information costs accounted for a major share of ₹210 lakhs (84.63%) followed by the enforcement cost, ₹38.14 lakhs (15.37%).

Matsya SHG of Bengare in Karnataka

Karshakasree SHG, Vegetable farming & Ornametnal fish culture, Elamkunnappuzha, Kerala

Kadal thamarai SHG, Sea weed culture Unit, Pamban, Tamil Nadu

In Tamil Nadu State, the willingness to pay (WTP) for the SFB, the traditional boat owners were ready to pay ₹950 for imposing a ban of 30 days to ₹4,375 for imposing a ban of 120 days. In case of motorized boat owners, the average WTP ranged from ₹1150 for a 30 day ban to ₹6458 for a ban of 120 days duration

The Willingness to Accept (WTA) ranged from ₹34167 for a period of 30 days ban to ₹170003 for 120 days ban for a mechanized boat owner. The average WTA for the trawl boat crew or labourers ranged from ₹11187 for a period of 30 days ban to ₹79067 for a ban period of 120 days, in Tamil Nadu State

AGRICULTURAL TECHNOLOGY INFORMATION CENTRE ATIC

Beneficiaries and revenue generation

The number of visitors to the institute consisting of students, fishermen, farmers and entrepreneurs managed through ATIC has increased tremendously over the yea₹ A total of 8,218 visitors including 7861 students, 101 farmers and 256 entrepreneurs visited the institute during 2014-15 and benefitted through the technological know-how from various departments, labs and biodiversity museum of the institute.

A total of 438 fishermen and fish farmers benefitted through the various products and services of CMFRI

The annual revenue generated through the sale of products and services for the financial year 2014-15 was ₹ 227700/-.

Training programmes organized

Training programme on "Marine ornamental fish harvesting and aquarium management techniques" from 27th May to 5th June, 2014 at Mandapam Regional Centre of CMFRI for 26 participants consisting of farmers, entrepreneurs and hobbyists.

Inauguration of ATIC-KVK sales counter by Dr.R.Narayanakumar, Head, SEETTDivision

Training programme on "Modern approaches in Aquaculture" was organized from 10th October 2014 to 23rd October 2014 at ATIC, CMFRI, Kochi for 53 Vocational Higher Secondary School students.

New Initiatives

Opening of sales counter

Sales Counter in collaboration with KVK has been opened up for intensive selling of technologies and services on 10th November 2014.

Economic empowerment of fisher

Director, CMFRI inaugurating the sale of cleaned tray packed fish of women self-help group members

women involved in edible oyster farming by promoting the sale of their value added fish products through the ATIC sales counter as an alternate livelihood.

New charts and flyers on latest CMFRI technologies and products were developed for dissemination of information to different stakeholders and for sales promotion.

Initiatives for getting food safety registration (FSSAI) for CMFRI products

Information on CMFRI technology products and services with their respective rates were included in the CMFRI website for wider publicity

New mail ID atic.cmfri@gmail.com for facilitating email correspondence of various stakeholde₹

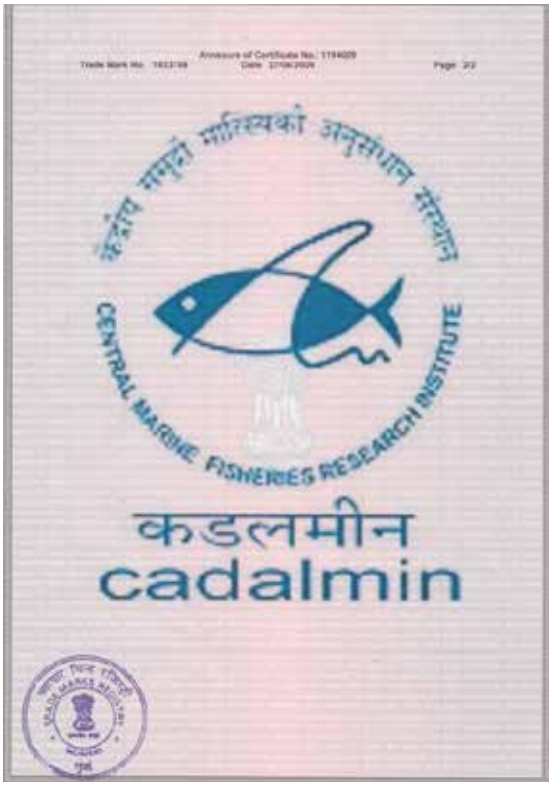
INTELLECTUAL PROPERTY MANAGEMENT

Trademark registered

The Trademarks Registrar has called for a detailed hearing on the registrability of the CMFRI Trade Mark "Cadalmin" application numbered 1833767 and 1833768 in class 31 and 35 at the Office of the Trademark Registrar, Chennai. As the trademark has been officially acknowledged and numbered by the trademarks registry of Intellectual Property, India, CMFRI can use 'CadalminTM' for the products and services of the institute. The trademark has been granted registration 'CadalminR' by the Government of India on 05-12-2014, giving CMFRI exclusive rights over this trademark in India.

The registration will enable CMFRI to approach the Courts in India if someone attempts to manufacture/market their products with any mark that is identical or similar to Cadalmin.


GOVERNMENT OF INDIA
TRADE MARKS REGISTRY
Trade Marks Act, 1999
Certificate of Registration of Trade Mark, Section 23 (2), Rule 62 (1)
CHENNAI



CMFRI Trademark

This registration also enables CMFRI to sell the products bearing "Cadalmin" in the event of CMFRI intending to do so.

TRADEMARK		Registration No
Class 31 (Food for fish, seeds)	CadalminTM	1833767
Class 35 (Trading and Marketing)	CadalminTM	1833768

Overview of IP assets

No: of technologies licensed	:	2
No: of patents (applied)	:	20
No: of Trademarks	:	1
No: of Copyrights	:	4

OTHER ACTIVITIES

1. Executing the committed objectives under the IP & TM project entitled "Intellectual property management and transfer/commercialisation of Agricultural technology scheme" for augmenting facilities at the disposal of the IPR Cell of the Institute.

2. Review on the Patent Search Database and Engines.

3. Submission of inputs with respect to the technologies of CMFRI for presentation in the various Conference–cum-exhibitions.

4. Inputs on the Agreement on different national and international research and Academic Exchange programmes between CMFRI (first party) and the second parties.

5. Report to ZTMC & BPDU unit in CIFT Cochin in the format of Results Framework document (RFD) regarding success stories, patent filed, and technology commercialised from CMFRI: Documented the success stories incorporating the salient achievements of CMFRI, and submitted to BPD unit south zone.

6. Time to time submission of Self-review of the XI Plan Scheme: Submitted to ICAR with respect to Intellectual Property Management and Transfer/ Commercialization of Agricultural Technology in CMFRI and audit memos.

7. Documented the success stories incorporating the salient achievements of CMFRI (IP and Technology Management) regarding technologies provided by the Institute.

LIBRARY AND DOCUMENTATION

Library and Documentation Centre plays a key role in the research and development activities of the Institute. Library extended its services to 3117 users during the period, including users from Universities, Colleges and other Research Institutes. In 2014, a webpage on "Library and Publications" has been created in the modified website of the Institute.

CMFRI Repository - Eprints@CMFRI

The Institute Open access Repository, Eprints@CMFRI continued its service with newly added 257 articles. Worldwide usage statistics for the period shows that 199 countries used our repository for more than 1 lakh sessions. As per 2014 ranking, Eprints@CMFRI got 352nd position among world repositories and 3rd among Indian repositories. Among ICAR institutes, Eprints@CMFRI stands the first.

Usage Report 2014-15

Top 10 Countries

(out of 199)

Country/Territory	Visits
India	66827
United States	5124
Philippines	2571
Indonesia	2046
Malaysia	1922
United Kingdom	1336
Spain	14 81
Australia	1273
Thailand	956
Japan	899

Online Journals

Sixty seve international as well as national were subscribed along with online versions. Access to 82 core journals have been activated in the Institute website along with CeRA subscribed journals under Institute IP address. Full text of the journals can be downloaded at HQs as well as at Regional/ Research Centres of CMFRI through intranet. Two hunrded and fiftypen access journals on fisheries and allied subjects are also activated in the website for easy access from HQs/RCs. Two Online databases *viz*., ASFA – Aquatic Sciences and Fisheries Abstracts (Access from 1971) and Zootaxa (Online Taxonomy Data base) were alos subscribed.

Current Awareness Service

Current Awareness Service, the monthly digital magazine of Library hosted in the intranet displays the content pages of journals received for the month and list of new additions to Library.

Online Document Delivery

Information on release of new books, activation of databases and online journals and other timely information from Library were informed to all scientists in HQs and RCs of CMFRI by email.

Newspaper Clippings

Six hundred and ninety clippings on fisheries, aquaculture and other related areas were compiled. Links to online versions of Newspaper clippings were uploaded in the library webpage and made available to HQs and RCs of CMFRI.

Indian Journal of Fisheries

Indian Journal of Fisheries is indexed in Thomson Reuter's Science Citation Index and Elsevier's Scopus and other databases. The journal has International Impact Factor 0.198 and NAAS rating of 6.2 (2013-14).

Exchange of Publications

The library maintains exchange relationship with various National and International Research Institutes, Universities and other organizations for Institute publications. Mailing lists are maintained for free distribution of Institute publications.

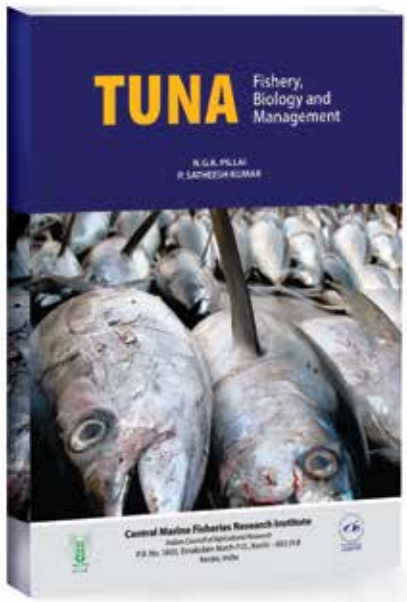
CMFRI Publications

1. Indian Journal of Fisheries Vol. 61 (1-4) 2014
2. CMFRI Annual Report 2013-2014
3. Marine Fisheries Information Service T&E Series No. 219-220
4. Cadalmin- CMFRI Newsletter No. 140-142
5. CMFRI Special Publication No.115, 117
6. CMFRI Marine Fisheries Policy Series No. 1
7. Books
    - Tuna: Fishery, Biology and Management
    - Methodologies for studying finfish and shellfish biology
    - Livelihood Status of Fishers in India
8. Other Publications
    - Marine Fish Landings in India – 2014
    - ISO 9001: 2008 Quality Management System
      Quality System Manual
    - Fish Stock Assessment and Management
9. Pamphlets
    - Hatchery Technology for Perna viridis spat production
    - Central Marine Fisheries Research Institute - in service to the Nation

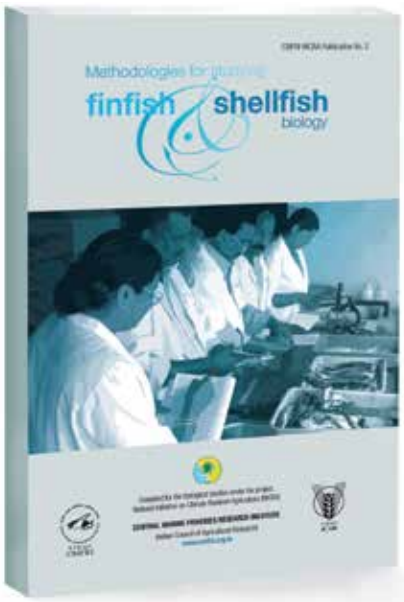
- Fishing Vessel Silver Pompano - A CMFRI-NICRA Initiative.
- The bane of juvenile fish catches.
- Central Marine Fisheries Research Institute, Karwar Research Centre, Karwar, Uttara Kannada, Karnataka, India.
- CMFRI Research Vessel R.V. Cadalmin-I.
- Monitoring neoplasia/tumors in marine fish
- Seed production and cage culture of pearl spot (Malayalam)
- Cage culture of grey mullet (Mugil cephalus) (Malayalam)
- Cage culture of GIFT Tilapia: A farming option during monsoon season in traditional shrimp ponds
- Cage culture of GIFT Tilapia: A farming option during monsoon season in traditional shrimp ponds (Malayalam)
- Dismantling and re-assembling type cages for open water aquaculture (Malayalam)
- Culture of grey mullet (Mugil cephalus) in backwater cage.
- Save our sharks
- Climate change and the man (Malayalam)

10. Posters
    - Hatchery Technology for Perna viridis spat production
    - Portunid Crab Resources of India
    - Elasmobranch resources of the southwest coast of India, Part 1 – Sharks

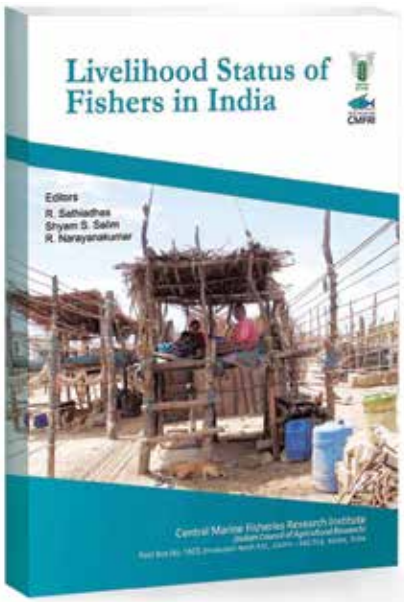
Books



Tuna Fishery: Biology and Management



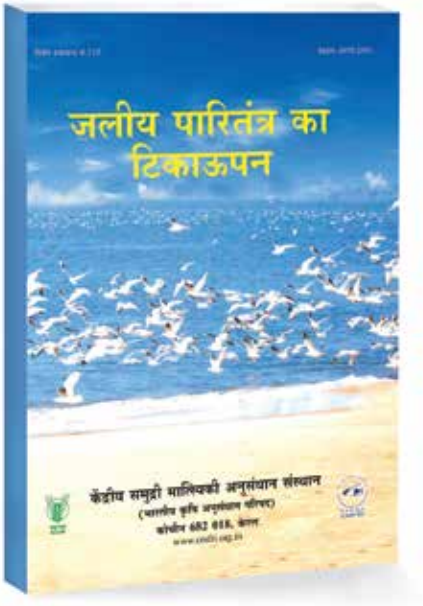
Methodologies for Studying Finfish and Shellfish Biology



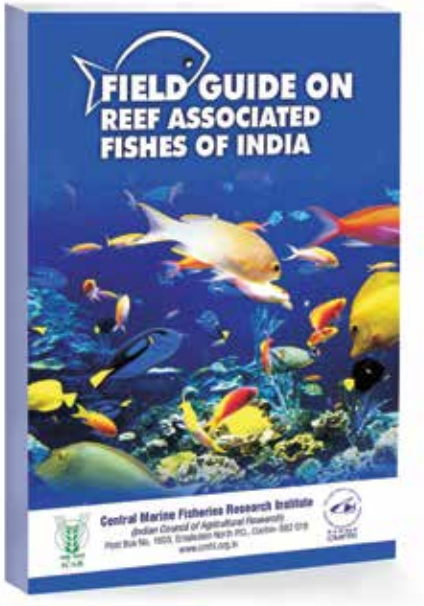
Livelihood Status of Fishers in India

Special Publications

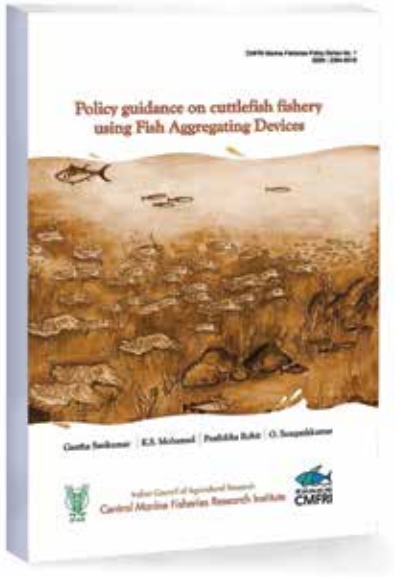
Marine Fisheries Policy Series



CMFRI Spl. Pub. No. 115
Jaleey Parithanthru ka Tikaupan (An appraisal of sustainability of Aquatic Ecosystems)



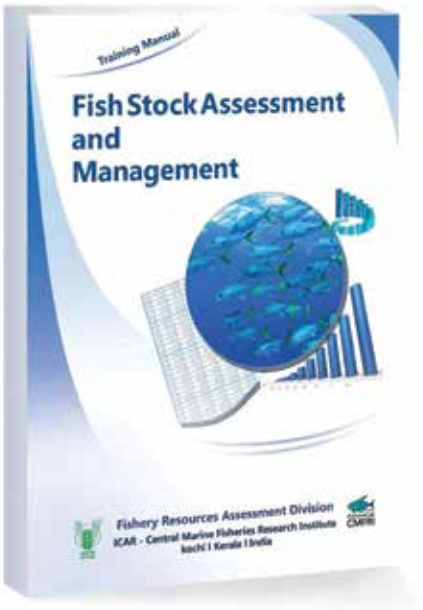
CMFRI Spl. Pub. No. 117
Field Guide on Reef Associated Fishes of India



CMFRI Marine Fisheries Policy Series No. 1
Policy guidance on cuttlefish fishery using Fish Aggregating Devices

Other Publications

Marine Fish Landings in India 2014



Fish Stock Assessment and Management

Posters

Hatchery Technology for Perna viridis Spat Production

Portunid Crab Resources of India

Elasmobranch resources of the southwest coast of India, Part 1 - Sharks

Pamphlets

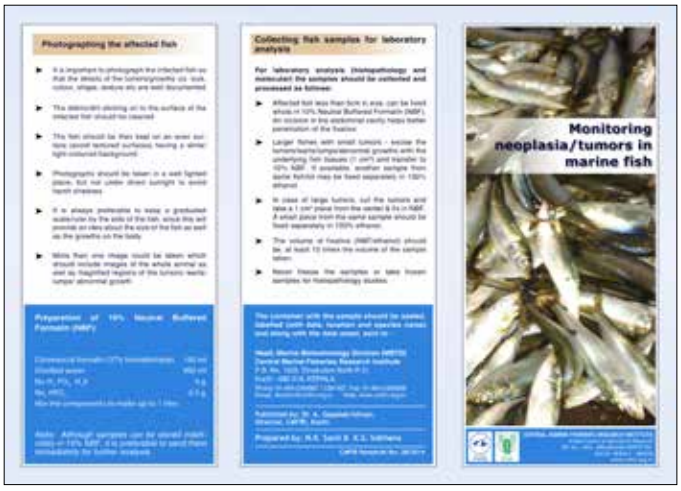
Fishing Vessel Silver Pompano - A CMFRI-NICRA Initiative

Fishing Vessel Silver Pompano - A CMFRI Research Vessel R.V. Cadalmin-I-NICRA Initiative

Hatchery Technology for *Perna viridis*

The bane of juvenile fish catches

CMFRI - Karwar Research Centre, Karwar, Uttara Kannada, Karnataka, India



Monitoring neoplasia/tumors in marine fish

BUDGET & EXPENDITURE 2014-15

The Budget & Expenditure under Non-Plan & Plan for the financial year 2014-15 in respect of CMFRI, Kochi (Figures in lakhs)

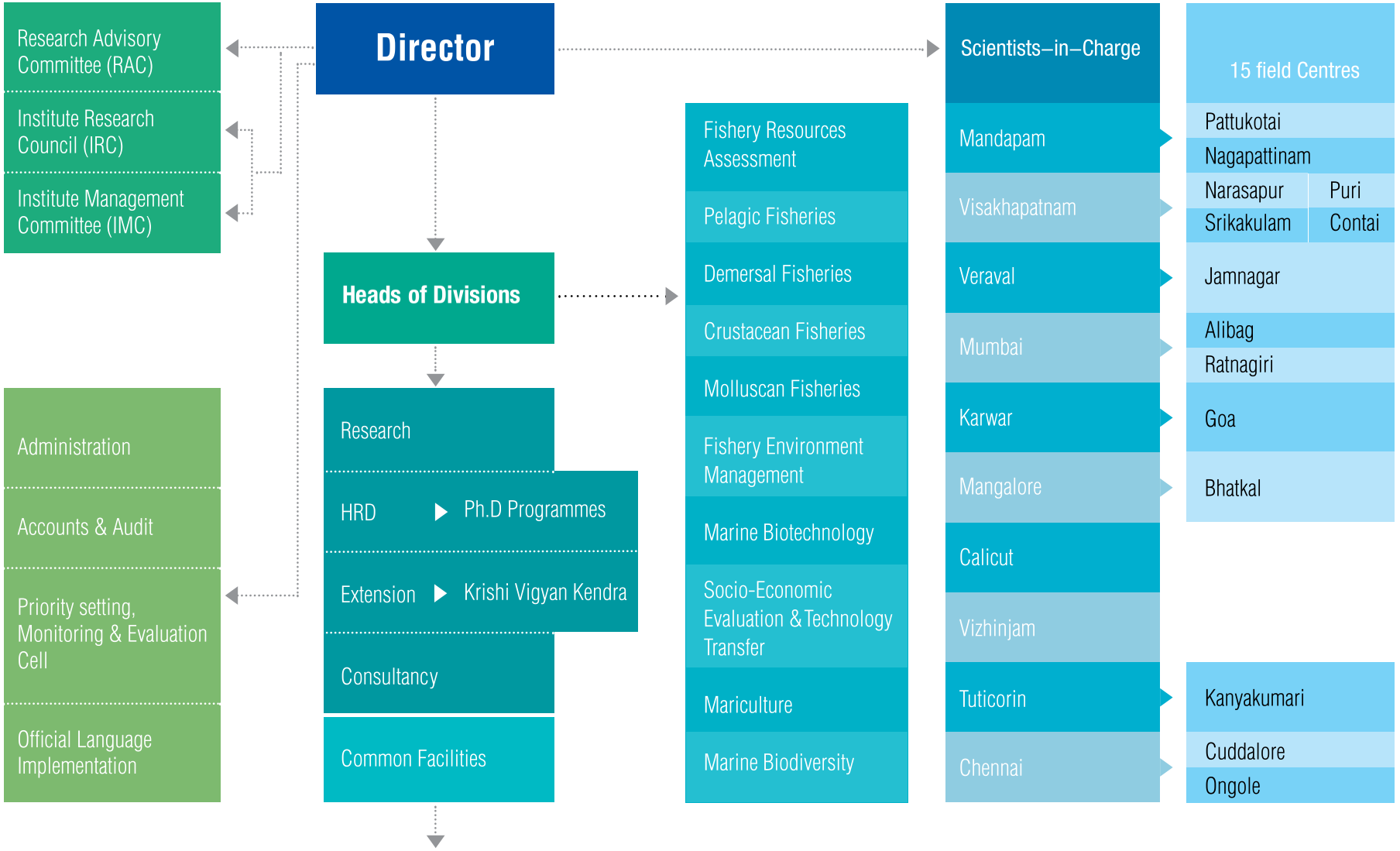
Budget Head	Non-Plan		Plan	
	Budget	Expenditure	Budget	Expenditure
Revenue				
Estt. Charges	4200.00	4193.01	0.00	0.00
OTA	0.60	0.6	0.00	0.00
TA	37.00	37.00	110.00	110.00
Other Charges	574.00	574.00	797.00	797.00
Works Repair & Maintenance				
Office Buildings	150.55	150.92	0.00	0.00
Residential Buildings	20.00	21.52	0.00	0.00
Minor Work	10.53	8.64	0.00	0.00
Miscellaneous Expenses (including HRD)	21.38	21.38	15.00	15.00
Tribal Sub Plan - General	0.00	0.00	10.00	10.00
Capital				
Equipments	15.00	19.74	180.00	180.02
Information Technology	0.00	0.00	10.00	9.98
Library	0.00	0.00	50.00	50.00
Vessel	4.75	0.00	0.00	0.00
Furniture & Fixtures	3.00	3.01	30.00	30.00
Works	0.00	0.00	85.00	85.00
Minor Work	0.00	0.00	0.00	0.00
Tribal Sub Plan - Capital	0.00	0.00	8.00	8.00
TOTAL	**5036.81**	**5029.82**	**1295.00**	**1295.00**

	Budget	Expenditure
Pension	4170.00	4170.00
Loans & Advances	30.00	28.62

Other Projects	Receipts (Including Opening Balance)	Expenditure	Refund
Winter/Summer School	6.00	6.28	0.00
Emeritus	19.96	17.82	0.00
NAIP	26.27	1.85	24.42
NICRA	244.30	243.41	0.00
National Fund Schemes	52.42	47.45	0.00
Other Plan Schemes	70.61	30.82	0.34
Deposit Schemes (Externally funded)	454.77	267.15	3.91
KVK, Narakkal	95.63	95.50	0.00
Consultancies	565.80	132.88	0.00

Revenue receipts		
Head	Target	Achievement
Income from Sales/services	24.70	30.87
Fee/Subscription	13.20	29.43
Income from Royalty, Publication etc.	3.50	1.96
Other Income	0.0	77.79
STD Interest	0.0	41.26
Sale of Asset	0.0	2.3
Recoveries on Loans & Advances	0.0	39.97
CPWD/Grants Refund	0.0	49.13
TOTAL	**41.40**	**272.71**

ORGANOGRAM


Director
Research Advisory Committee (RAC)
Institute Research Council (IRC)
Institute Management Committee (IMC)
Heads of Divisions
Administration
Accounts & Audit
Priority setting, Monitoring & Evaluation Cell
Official Language Implementation
Research
HRD
Ph.D Programmes
Extension
Krishi Vigyan Kendra
Consultancy
Common Facilities
Fishery Resources Assessment
Pelagic Fisheries
Demersal Fisheries
Crustacean Fisheries
Molluscan Fisheries
Fishery Environment Management
Marine Biotechnology
Socio-Economic Evaluation & Technology Transfer
Mariculture
Marine Biodiversity
Scientists–in–Charge
Mandapam
Visakhapatnam
Veraval
Mumbai
Karwar
Mangalore
Calicut
Vizhinjam
Tuticorin
Chennai
15 field Centres
Pattukotai
Nagapattinam
Narasapur
Puri
Srikakulam
Contai
Jamnagar
Alibag
Ratnagiri
Goa
Bhatkal
Kanyakumari
Cuddalore
Ongole
Agricultural Knowledge Management Unit
Library & Documentation Centre
Research Vessels
ATIC
Marine Aquarium
Research Labs
Hatcheries
Marine Biodiversity Museum

PERSONNEL

As on 01-06-2015/ Not a gradation list

SCIENTIFIC

Sl.No.	Name	Designation
	CMFRI, Kochi	
1.	Dr. A. Gopalakrishnan	Director & Principal Scientist
2.	Dr. K. Sunilkumar Mohammed	Principal Scientist & Head, MFD
3.	Dr. P.U. Zachariah	Principal Scientist & Head, DFD
4.	Dr. G. Maheswarudu	Principal Scientist & Head, CFD
5.	Dr. R. Narayanakumar	Principal Scientist, & Head, SEETTD
6.	Dr. T.V. Sathianandan	Principal Scientist & Head, FRAD
7.	Dr. K.K. Joshi	Principal Scientist & Head, MBD
8.	Dr. (Smt.) V. Kripa	Principal Scientist & Head in charge, FEMD
9.	Dr. P. Kaladharan	Principal Scientist
10.	Dr. (Smt.) Josileen Jose	Principal Scientist
11.	Dr. (Smt.) Imelda Joseph	Principal Scientist
12.	Dr. K. Madhu	Principal Scientist
13.	Dr. (Smt.) K.S. Sobhana	Principal Scientist
14.	Dr. (Smt.) Shoji Joseph	Principal Scientist
15.	Dr. E.M. Abdusamad	Principal Scientist
16.	Dr. P. Vijayagopal	Principal Scientist
17.	Dr. J. Jayasankar	Principal Scientist
18.	Dr. Boby Ignatius	Principal Scientist
19.	Dr. (Smt.) Rema Madhu	Principal Scientist
20.	Dr. P. Laxmilatha	Principal Scientist
21.	Dr. (Smt.) D. Prema	Principal Scientist
22.	Dr. C. Ramachandran	Principal Scientist
23.	Dr. (Smt.) Molly Varghese	Principal Scientist
24.	Dr. (Smt.) Somy Kuriakose	Principal Scientist
25.	Dr. V.P. Vipin Kumar	Principal Scientist
26.	Dr. (Smt.) S.Lakshmi Pillai	Principal Scientist
27.	Dr. T.M. Najmudeen	Senior Scientist
28.	Dr. Shyam S. Salim	Senior Scientist
29.	Dr. R. Jeyabaskaran	Senior Scientist
30.	Dr. (Smt.) Mini. K.G.	Senior Scientist
31.	Dr. Grinson George	Senior Scientist
32.	Dr. (Smt.) U. Ganga	Senior Scientist
33.	Dr. (Smt.) Rekha J. Nair	Senior Scientist
34.	Dr. Kajal Chakraborty	Senior Scientist
35.	Dr. (Smt.) Rekhadevi Chakraborty	Senior Scientist
36.	Dr. (Smt.) N. Aswathy	Senior Scientist
37.	Shri N.K. Sanil	Scientist
38.	Shri Wilson T. Mathew	Scientist
39.	Dr. V. Venkatesan	Scientist
40.	Dr. Pradeep M.A	Scientist
41.	Smt.. Sandhya Sukumaran	Scientist
42.	Smt. Divya Viswambharan	Scientist
43.	Ms. Reshma K.J	Scientist
44.	Dr. (Smt.) Vidya R	Scientist
45.	Shri Linga Prabhu D	Scientist
46.	Shri Sanal Ebenezeer	Scientist
47.	Shri Vivekanand Bharti	Scientist
48.	Ms. Ramya Raj	Scientist
49.	Ms. Remya.L	Scientist
50.	Shri Sukhdhane Kapil Sukhadeo	Scientist
51.	Shri Subal Kumar Roul	Scientist
52.	Shri Rajesh Kumar Pradhan	Scientist
53.	Ms. E.M. Chhandaprajnadarsini	Scientist
54.	Shri Rajkumar.M.	Scientist
55.	Shri Nakhawa Ajay Dayaram	Scientist
56.	Ms. Saloni Shivam	Scientist
57.	Shri S. Thirumalaiselvam	Scientist
58.	Dr. P. Shinoj	Scientist
	Mandapam R.C	
59.	Dr. A.K. Abdul Nazar	Senior Scientist & SIC
60.	Dr. I. Rajendran	Senior Scientist
61.	Dr. Rengarajan Jayakumar	Senior Scientist
62.	Dr. G. Tamilmani	Scientist
63.	Dr.M. Sakthivel	Scientist
64.	Shri Johnson B.	Scientist
65.	Dr. P. Rameshkumar	Scientist
66.	Shri Saravanan R.	Scientist
67.	Dr. Amir Kumar Samal	Scientist
68.	Dr. Anikuttan K.K	Scientist
69.	Ms. Surya S	Scientist
70.	Ms. Jeena N.S	Scientist

71.	Shri S. Chandrasekar	Scientist
Visakhapatnam R.C		
72.	Dr. Shubhadeep Ghosh	Senior Scientist & SIC
73.	Shri Ritesh Ranjan	Scientist
74.	Smt. Biji Xavier	Scientist
75.	Kum. Muktha M.	Scientist
76.	Shri Loveson Edward L.	Scientist
77.	Shri Nenavath Rajendra Naik	Scientist
78.	Shri Pralaya Ranjan Behera	Scientist
79.	Dr. Sekar Megarajan	Scientist
80.	Ms. Jasmin F	Scientist
Veraval R.C		
81.	Shri K. Mohammed Koya	Scientist &SIC
82.	Shri Sreenath K.R.	Scientist
83.	Shri Gyanranjan Dash	Scientist
84.	Smt. Swathipriyanka Sen Dash	Scientist
85.	Dr. Divu Damodaran	Scientist
86.	Shri Vinaya Kumar Vase	Scientist
Madras. R.C		
87.	Dr. (Ms.) A. Margaret Muthu Rathinam	Principal Scientist & SIC
88.	Dr. K. Vijayakumaran	Principal Scientist
89.	Dr. Joe K. Kizhakudan	Principal Scientist
90.	Dr. Vidya Jayasankar	Senior Scientist
91.	Dr. (Smt.) Sobha Joe Kizhakudan	Senior Scientist
92.	Smt.. P. Hemasankari	Scientist
93.	Dr. (Mrs.) R. Geetha	Scientist
94.	Dr. Srinivasa Raghavan V	Scientist
95.	Ms. Indira Divipala	Scientist
Mangalore R.C		
96.	Dr. Prathibha Rohit	Principal Scientist &SIC
97.	Dr. A.P. Dinesh Babu	Principal Scientist
98.	Dr. K.M. Rajesh	Senior Scientist
99.	Dr. (Smt.) Bindu Sulochanan	Senior Scientist
100.	Dr. P.S. Swathilekshmi	Principal Scientist
101.	Dr. Sujitha Thomas	Principal Scientist
102.	Dr. (Smt.) Geetha Sasikumar	Principal Scientist
Calicut R.C		
103.	Dr. P.K. Asokan	Principal Scientist &SIC
104.	Dr. Gulshad Mohamed	Principal Scientist
105.	Dr. K. Vinod	Principal Scientist
106.	Shri K.P. Said Koya	Scientist (Selection Grade)
107.	Ms. Shilta M.T	Scientist
108.	Dr. Suresh Babu.P.P	Scientist
Karwar R.C		
109.	Dr. K.K. Philipose	Principal Scientist & SIC
110.	Dr. Jayasree Loka	Senior Scientist
111.	Dr. S.R. Krupesa Sharma	Principal Scientist
112.	Dr. T. Senthil Murugan	Senior Scientist
Mumbai R.C		
113.	Dr. Veerendra Veer Singh	Principal Scientist & SIC
114.	Ms.. Anulekshmi Chellappan	Scientist
115.	Shri Purushottama G.B.	Scientist
116.	Shri S. Ramkumar	Scientist
117.	Shri Ratheesh Kumar R	Scientist
118.	Shri Akhilesh K.V	Scientist
Tuticorin R.C		
119.	Dr. P.P. Manoj Kumar	Principal Scientist & SIC
120.	Dr. M.S. Madan	Principal Scientist
121.	Dr. I. Jagadis	Principal Scientist
122.	Dr. M. Sivadas	Principal Scientist
123.	Dr. (Smt.) Asha. P.S.	Principal Scientist
124.	Dr. (Smt.) P.T. Sarada	Principal Scientist
125.	Dr. (Mrs.) C.P. Suja	Senior Scientist
126.	Shri C Kalidas	Scientist
127.	Shri Renjith. L	Scientist
128.	Ms. Kavitha M	Scientist
Vizhinjam R.C		
129.	Dr. M.K. Anil	Principal Scientist & SIC
130.	Dr. B. Santhosh	Principal Scientist
131.	Smt. S. Jasmine	Senior Scientist
132.	Dr.(Smt.) K.N. Saleela	Scientist
Puri F.C		
133.	Dr. (Mrs.) Reeta Jayasankar	Principal Scientist
KVK, Narakkal		
134.	Dr. Shinoj Subramannian	Programme Coordinator

TECHNICAL

Sl.No.	Name	Designation
CMFRI, Kochi		
1.	Shri N. Venugopal	Chief Technical Officer
2.	Shri P.K. Harikumar	Assistant Chief Technical Officer
3.	Shri N. Viswanathan	Assistant Chief Technical Officer (Civil)
4.	Smt. E.K. Uma	Assistant Chief Technical Officer (Hindi Translator)
5.	Shri D. Pugazhendi	Assistant Chief Technical Officer
6.	Smt. K. Ramani	Senior Technical Officer
7.	Shri P.S. Anilkumar	Senior Technical Officer
8.	Dr. V. Mohan	Senior Technical Officer (Library)
9.	Smt. P. Geetha	Senior Technical Officer (Library)
10.	Smt. G. Shylaja	Senior Technical Officer
11.	Dr. M.P. Paulton	Senior Technical Officer (Training)
12.	Smt. Jenni. B	Senior Technical Officer
13.	Shri S. Yadavayya	Technical Officer (Motor Driver)
14.	Smt. K.V. Rema	Technical Officer
15.	Smt. P.M. Geetha	Technical Officer (Museum)
16.	Smt. K.P. Salini	Technical Officer
17.	Shri K.M. Venugopalan	Technical Officer
18.	Shri V.J. Thomas	Technical Officer
19.	Smt. P.K. Seetha	Technical Officer
20.	Shri M.B. Seynudeen	Technical Officer
21.	Smt. Lata L. Khambadkar	Technical Officer
22.	Shri Sijo Paul	Technical Officer
23.	Shri A. Padmanabha	Technical Officer (Electrical)
24.	Shri K.N. Pushkaran	Senior Technical Assistant
25.	Shri P.K. Baby	Senior Technical Assistant
26.	Shri A.Y. Jacob	Senior Technical Assistant
27.	Shri K.G. Baby	Senior Technical Assistant

28.	Smt. Sindhu K. Augustine	Senior Technical Assistant
29.	Shri K.G. Radhakrishnan Nair	Senior Technical Assistant (Motor Driver)
30.	Shri V.K. Manu	Senior Technical Assistant (Programme Assistant - Computer)
31.	Shri V. Sethuraman	Senior Technical Assistant
32.	Shri S. Nandakumar Rao	Technical Assistant
33.	Shri N.K. Harshan	Technical Assistant
34.	Shri D. Prakasan	Technical Assistant
35.	Shri P.S. Alloycious	Technical Assistant
36.	Shri K.C. Hezhakiel	Technical Assistant
37.	Shri Baby Mathew	Technical Assistant (Motor Driver)
38.	Shri Arun Surendran P.S	Technical Assistant
39.	Shri Retheesh. T	Technical Assistant
40.	Shri Sajikumar K.K	Technical Assistant
41.	Shri Retheesh T.B.	Technical Assistant
42.	Smt. Anusree V.Nair	Technical Assistant
43.	Shri Binoy Bhaskaran	Technical Assistant
44.	Shri Ragesh .N	Technical Assistant
45.	Sajeela.K.A	Technical Assistant
46.	Sayooj P	Technical Assistant
47.	Smt. Vandana. V	Technical Assistant(Hindi Translator)
48.	Shri K. Solaman	T-I-3 (Technical Assistant)
49.	Shri M.N. Sathyan	Senior Technician (Motor Driver)
50.	Shri C.V. Jayakumar	Senior Technician (Press & Editorial)
51.	Shri K.M. David	Senior Technician(Artist)
52.	Shri Manjeesh .R	Senior Technician (Computer Application)
53.	Shri P.R. Abhilash	Senior Technician (Exhibition Assistant)
54.	Shri David Babu	Senior Technician
55.	Shri M. Radhakrishnan	Technician
56.	Smt. Dhanya G.	Technician
57.	Shri M.P. Mohandas	Technician
58.	Shri V.H. Venu	Technician
59.	Smt. J. Sudhadevi	Technician
60.	Smt. Shyamala. M.P.	Technician
61.	Shri P.V. Sunil	Technician
62.	Shri Shaji. A.K.	Technician
63.	Smt. Sheela. P.P.	Technician
64.	Shri Jestin Joy. K.M.	Technician
65.	Shri Sreekumar. K.M.	Technician
66.	Shri Vijayan. M.T.	Technician
67.	Shri Paulose Jacob Peter	Technician
68.	Shri Kishor T.G	Technician
69.	Shri Sreesanth.L	Technician
70.	Shri Sunil.K.T.S	Technician
Quilon F.C		
71.	Shri Thomas Kuruvila	Senior Technical Assistant
Mandapam R.C		
72.	Shri P. Chithamparam	Senior Technical Officer (Library)
73.	Shri N. Ramamurthy	Senior Technical Officer (Museum)
74.	Shri I. Mendonza Xavier	Technical Officer (Draughtsman)
75.	Shri P.M.A. Muheedu	Technical Officer (Deckhand)
76.	Shri D. Anandan	Technical Officer (Deckhand)
77.	Shri G. Subbaraman	Technical Officer
78.	Shri P. Muthukrishnan	Technical Officer (Skin Diver)
79.	Shri A. Gandhi	Senior Technical Assistant
80.	Shri A. Vairamani	Senior Technical Assistant
81.	Shri A. Shanmughavel	Senior Technical Assistant
82.	Shri V. Sathyanesan	Senior Technical Assistant(Library)
83.	Shri.P.Villan	Technical Assistant
84.	Shri N. Boominathan	Technical Assistant
85.	Shri M. Asokan	Technical Assistant (Painter-cum-Polisher)
86.	Shri G. Hanumantha Rao	Technical Assistant
87.	Shri Ashok Maharshi	Technical Assistant
88.	Shri M. Anbarasu	Technical Assistant
89.	Shri Ravi Kumar Avadhanula	Technical Assistant
90.	Shri Vijaya Karthikeyan	Senior Technician (Electrician)
91.	Shri M. Palanichamy	Senior Technician (Electrician)
92.	Shri K. Shanmughanathan	Technician
93.	Shri R. Selvakumar	Technician
94.	Shri S. Murugaboopathy	Technician
95.	Shri N. Ramakrishnan	Technician
96.	Shri P. Rajendran	Technician
97.	Shri S.M. Sikkender Batcha	Technician
98.	Shri I. Syed Sadiq	Technician
99.	Shri V. Muniasamy	Technician
100.	Shri B. Kathiresan	Technician
101.	Shri K. Muniyasamy	Technician
102.	Shri M. Ganesan	Technician
103.	Shri M. Thayalan	Technician
104.	Shri K. Senthil Kumar	Technician
Pattukottai F.C		
105.	Shri A. Kumar	Senior Technical Officer
Visakhapatnam R.C		
106.	Dr. Biswajit Dash	Senior Technical Officer
107.	Dr. Madhumita Das	Senior Technical Officer
108.	Dr. Phalguni Pattnaik	Senior Technical Officer
109.	Shri R.V.D. Prabhakar	Technical Officer
110.	Shri M. Samuel Sumithrudu	Technical Officer
111.	Shri M. Prasada Rao	Technical Officer
112.	Shri S. Nageswara Rao	Technical Officer
113.	Shri P. Venkataramana	Senior Technical Assistant
114.	Ms. Veena Shettigar	Senior Technical Assistant
115.	Shri Mamidi Satishkumar	Technical Assistant
116.	Shri K. Lakshminarayana	Technical Assistant (Motor Driver)
117.	Shri R.P. Venkatesh	Senior Technician (Fitter)
118.	Shri Sangaru Padmaja Rani	Technician
119.	Shri Durga Suresh Relangi	Technician
120.	Shri D. Bhaskara Rao	Technician
121.	Shri D. Jaganna	Technician
122.	Shri C.H. Moshe	Technician
123.	Shri Jishnudev M.A	Technician

Narsapur F.C		
124.	Shri S. Tatabhai	Senior Technician
Contai F.C		
125.	Shri Swapan Kumar Kar	Senior Technical Assistant
126.	Shri Bijoy Krishna Burman	Senior Technical Assistant
Puri F.C		
127.	Shri Sukhdev Bar	Technical Officer
Srikakulam F.C		
128.	Shri Y.V.S. Suryanarayana	Technical Assistant
Veraval R.C		
129.	Shri Suresh Kumar Mojjada	Senior Technical Officer
130.	Shri H.K. Dhokia	Technical Officer
131.	Shri Vanvi Jayaanthilal Dayabhai	Senior Technical Assistant
132.	Shri Ladani Amrutlal Arjunbhai	Senior Technical Assistant
133.	Shri Polara Jamnadas Premji	Senior Technical Assistant
134.	Shri Chudasama Ramji Raja	Technical Assistant
135.	Ms. Bharadiya Sangita Aravindkumar	Technical Assistant
136.	Shri H.M. Bhint	Senior Technician
137.	Shri Shiju P.	Technician
138.	Shri Makwana Somapitha	Technician
139.	Shri Chudasama Karsan Punja	Technician
Jamnagar F.C		
140.	Shri Makadia B.V.	Technical Officer
Madras R.C		
141.	Shri S. Mohan	Senior Technical Officer
142.	Smt. S. Gomathy	Senior Technical Officer
143.	Shri N. Rudhramurthy	Technical Officer
144.	Shri C. Manibal	Technical Officer (Deckhand)
145.	Shri S. Ganesan	Technical Officer (Deckhand)
146.	Shri V.S. Gopal	Technical Officer
147.	Shri P. Jaiganesh	Senior Technical Assistant
148.	Shri K.S. Shiak Mohamed Yousuf	Technical Assistant
149.	Shri S. Selvanidhi	Technical Assistant
150.	Shri M. Ravindran	Senior Technician
151.	Shri T. Nagalingam	Senior Technician
152.	Smt. I. Santhosi	Senior Technician
153.	Shri R. Vasu	Senior Technician
154.	Shri R. Sunder	Technician
155.	Shri V. Joseph Xavier	Technician
156.	Shri Bareen Mohamed	Technician
157.	Shri V. Sitaramacharyulu	Technician
158.	Shri S. Chandrasekharan	Technician
Kovalam F.C		
159.	Shri R. Ponniah	Senior Technical Assistant (Electrician)
Ongole F.C		
160.	Shri G. Sudhakar	Senior Technical Assistant
161.	Shri S.V. Subba Rao	Technical Assistant
Cuddalore F.C		
162.	Shri S. Pradeep	Technician
Mangalore R.C		
163.	Shri B. Sridhara	Technical Officer
164.	Shri N. Chennappa Gowda	Technical Officer
165.	Shri V. Lingappa	Senior Technical Assistant
166.	Shri M. Chaniappa	Senior Technical Assistant
167.	Shri R. Appayya Naik	Senior Technical Assistant
168.	Shri G.D. Nataraja	Senior Technical Assistant
169.	Shri G. Sampathkumar	Senior Technical Assistant
170.	Shri P. Harshakumar	Technical Assistant (Motor Driver)
171.	Ms. Lavanya S.	Technical Assistant
172.	Shri Karamathullah Sahib. P	Technician
Bhatkal F.C		
173.	Shri Udaya V. Arghekar	Technical Officer
174.	Shri Ganesh Bhatkal	Technical Officer
Calicut R.C		
175.	Shri V.A. Kunhikoya	Senior Technical Officer
176.	Shri M.M. Bhaskaran	Senior Technical Assistant
177.	Shri K.C. Pradeep Kumar	Senior Technical Assistant
178.	Shri A. Anasukoya	Senior Technical Assistant
179.	Shri N.P. Ramachandran	Senior Technical Assistant
180.	Shri C. Chandran	Technical Assistant
181.	Smt. P. Renuka	Technician
Karwar R.C		
182.	Shri Fofandi Mahendra Kumar	Senior Technical Officer
183.	Shri K.C. Pandurangachar	Technical Officer
184.	Shri Narayan G. Vaidya	Technical Officer
185.	Shri S. Satyanarayan V. Pai	Technical Officer
186.	Shri C.G. Ulvekar	Technical Assistant
187.	Shri Narsimhulu Sadhu	Technical Assistant
188.	Ms. Sonali S. Mhaddolkar	Technical Assistant
189.	Shri Kodi Srinivasa Rao	Technical Assistant
190.	Shri Laxman Shanker Korabu	Senior Technician (Skin Diver)
191.	Shri N. Selvakumar	Technician
192.	Smt. Pramila Harish Borkar	Technician
Goa F.C		
193.	Shri Prakash C. Shetty	Technical Officer
Mumbai R.C		
194.	Shri C.K. Sajeev	Senior Technical Officer
195.	Shri Nilesh Anil Pawar	SeniorTechnical Officer
196.	Shri A.D. Sawant	Technical Officer
197.	Shri B.B. Chavan	Technical Officer
198.	Shri J.D. Sarang	Technical Officer
199.	Shri Baban N. Katkar	Technical Officer
200.	Shri S.D. Kamble	Technical Officer
201.	Shri Sujit S.K.	Senior Technical Assistant
202.	Shri D.G. Jadhav	Senior Technical Assistant
203.	Shri Jayadev S. Hotagi	Senior Technical Assistant
204.	Shri Thakurdas	Senior Technical Assistant
205.	Shri Punam Ashok Khandagle	Technical Assistant
206.	Shri Suresh Krishnaro Kamble	Technical Assistant
207.	Shri Sashikant R. Yadav	Technical Assistant (Motor Driver)
208.	Shri Vaibhav Dinkar Mhatre	Technical Assistant
209.	Shri Umesh Hari Rane	Senior Technician
210.	Shri Prabhakar Sankar Salvi	Senior Technician
211.	Shri M.P. Jadhav	Technician
212.	Shri Bhangare Sunil Ramachandra	Technician

213.	Shri Midhunraj N.K	Technician
Ratnagiri F.C		
214.	Shri Bashir Ahmed Adam Shilodar	Senior Technical Assistant
215.	Shri D.D. Sawant	Senior Technical Assistant
216.	Shri Kishor Raghunath Mainkar	Senior Technical Assistant
Tuticorin R.C		
217.	Shri K. Diwakar	Senior Technical Officer
218.	Shri R. Sekhar	Technical Officer (Deckhand)
219.	Shri S. Enasteen	Technical Officer (Deckhand)
220.	Shri N. Jesuraj	Technical Officer (Skin Diver)
221.	Shri S. Mohamed Sathakathullah	Senior Technical Assistant
222.	Shri U. Jeyaram	Senior Technical Assistant
223.	Shri S. Sekar V. Rayer	Senior Technical Assistant (Skin Diver)
224.	Shri J. Padmanathan	Technical Assistant
225.	Shri K.P. Kanthan	Senior Technician
226.	Shri K. John James	Senior Technician
227.	Smt. B. Koncies Mary	Technician
228.	Shri K. Murugan	Technician
229.	Shri S. Willington	Technician
230.	Shri N. Ramaswamy	Technician
Vizhinjam R.C		
231.	Shri V.A. Laslie	Senior Technical Officer
232.	Shri K.K. Suresh	Technical Officer
233.	Shri Jose Kingsly	Technical Officer
234.	Shri P. Hillary	Technical Officer (Deckhand)
235.	Shri V.P. Benziger	Technical Officer (Deckhand)
236.	Shri A. Udayakumar	Technical Officer
237.	Shri C. Unnikrishnan	Senior Technical Assistant
238.	Shri B. Raju	Technical Assistant
KVK, Narakkal		
239.	Smt. P. Sreelatha	Chief Technical Officer
240.	Shri Shoji Joy Edison	Senior Technical Officer (SMS-Horticulture)
241.	Shri F. Pushparaj Anjelo	Senior Technical Officer (SMS-Agricultural Extension)
242.	Dr. Karikkathil Smitha Sivadasan	Senior Technical Officer (SMS-Animal Husbandry)
243.	Dr. Vikas P.A	Senior Technical Officer (SMS-Fisheries)
244.	Ms. Dipti N.V	Senior Technical Assistant (Programme Assistant - Laboratory Technician)

ADMINISTRATIVE

Sl.No.	Name	Designation
CMFRI, Kochi		
1	Shri Rakesh Kumar	Chief Administrative Officer
2	Shri A.V. Joseph	Chief Finance & Accounts Officer
3	Shri V. Mohanan	Administrative Officer
4	Smt. Christina Joseph	Assistant Administrative Officer
5	Shri P. Krishnakumaran	Assistant Finance & Accounts Officer
6	Shri Thomas Joy	Assistant Finance & Accounts Officer
7	Smt. Meera. K.N.	Assistant Administrative Officer
8	Shri P.V. Devassy	Assistant Administrative Officer
9	Smt. C.M. Jenny	Assistant Administrative Officer
10	Smt. V.K. Sobha	Assistant Administrative Officer
11	Smt. Ponnamma Radhakrishnan	Assistant Administrative Officer
12	Smt. P.S. Sumathy	Assistant Administrative Officer
13	Shri K.S. Sreekumaran	Assistant Finance & Accounts Officer
14	Shri C.N. Chandrasekharan	Private Secretary
15	Smt. N.R. Lethadevi	Private Secretary
16	Smt. K.V. Sajitha	Private Secretary
17	Shri K. Ramadasan	Assistant
18	Smt. M.G.Chandramathy	Assistant
19	Smt. M. Safiyabi	Assistant
20	Shri C. Jayakanthan	Assistant
21	Shri P.P. Chandrasekharan Nair	Assistant
22	Shri Rishikesh Aandi	Assistant
23	Smt. Molly Lazer	Assistant
24	Smt. G. Ambika	Assistant
25	Smt. N.K. Suseela	Assistant
26	Shri K. Baburajan	Assistant
27	Smt. V. Jayalakshmi	Assistant
28	Smt. C.A. Leela	Assistant
29	Smt. Manjusha G. Menon	Assistant
30	Smt. Radhika Krishnan	Assistant
31	Ms. Soumya Surendran	Assistant
32	Ms. Ramya M	Assistant
33	Shri C.K. Sivadas	Assistant
34	Smt. P.K. Mary	Assistant
35	Smt. Binny Cherian	Assistant
36	Shri Santosh Kumar	Assistant
37	Smt. Gouri Hareendran	Assistant
38	Smt. T.C. Chandrika	Assistant
39	Shri K.S. Ajith	Assistant
40	Ms. Sumeena N.K	Assistant
41	Shri R. Chandrakesa Shenoi	Personal Assistant
42	Smt. P.K. Anitha	Personal Assistant
43	Shri C.D. Manoharan	Personal Assistant
44	Smt. P. Vineetha	Personal Assistant
45	Shri K.N. Murali	Personal Assistant
46	Smt. Bindu Sanjeev	Personal Assistant
47	Smt. K. Smitha	Personal Assistant
48	Smt. Saritha L.	Stenographer Grade III
49	Smt. Dhanya M.B	Stenographer Grade III
50	Smt. Zulekha	Stenographer Grade III
51	Shri A.K. Kunjipalu	Upper Division Clerk
52	Smt. C. Devaki	Upper Division Clerk
53	Shri K.P. John	Upper Division Clerk
54	Smt Annies Mary Paulose	Upper Division Clerk
55	Shri T.K. Sumesh	Upper Division Clerk
56	Shri K.S. Sunil Raj	Upper Division Clerk
57	Shri Sunil A.T	Upper Division Clerk
58	Shri Joseph Mathew	Upper Division Clerk
59	Smt. Deepa P.N.	Upper Division Clerk

60	Smt. Febeena P.A.	Upper Division Clerk
61	Smt. Manju Jose	Upper Division Clerk
62	Shri E.A. Roopesh	Upper Division Clerk
63	Smt. Sujatha K.K	Upper Division Clerk
64	Shri G.K. Rajan	Upper Division Clerk
65	Shri A. Yesudhas	Upper Division Clerk
66	Shri S. Sreekumar	Lower Division Clerk
67	Smt. Sreeja N.P	Lower Division Clerk
68	Ms. Sandhya C.K.	Lower Division Clerk
Mandapam R.C		
69	Shri V.C. Subhash	Assistant Administrative Officer
70	Smt. N. Gomathi	Private Secretary
71	Smt. M. Rameswari	Assistant
72	Shri B. Balasubramanian alias James	Upper Division Clerk
73	Shri M. Shahul Hameed	Lower Division Clerk
74	Shri M. Saravanan	Lower Division Clerk
75	Smt. M. Valarmathi	Lower Division Clerk
76	Shri R. Saravanan	Lower Division Clerk
77	Shri S. Maharajan	Lower Division Clerk
Visakhapatnam R.C		
78	Shri Ashish Chobey	Assistant Administrative Officer
79	Smt. G. Hemlata	Assistant Finance & Accounts Officer
80	Smt. B. Gauri	Assistant
81	Smt. D. Madhavi Latha	Assistant
82	Smt. N.C. Saroja	Upper Division Clerk
83	Shri L. Pydi Raju	Lower Division Clerk
Veraval R.C		
84	Shri Chandra Mauli Sharma	Assistant Administrative Officer
85	Shri Upendar Kumar	Assistant
86	Shri Vanvi Mansukhlal Madhavji	Assistant
87	Shri Solanki Mukesh Jeshabahi	Lower Division Clerk
88	Shri Rohit A. Chowda	Lower Division Clerk
89	Shri Pandya Jatin Kumar	Lower Division Clerk
Mangalore R.C		
90	Shri U. Purandhara Shetty	Assistant
Mumbai R.C		
91	Smt. Ashlesha Ashok Sawant	Assistant
92	Ms. Priyankakumari	Assistant
93	Shri Vinod P. Bhagayatkar	Upper Division Clerk
Tuticorin R.C		
94	Smt. S. Sarada	Assistant
95	Smt. C. Rajeswari	Assistant
96	Shri M. Samuthiram	Assistant
97	Smt. T. Mahalakshmi	Assistant
98	Shri J. Vinoth Prabhu Vaz	Upper Division Clerk
99	Smt. C. Pushparani	Upper Division Clerk
100	Shri A. Dickson Jebaraj	Upper Division Clerk
101	Shri W. Sathyavan Neelraj	Upper Division Clerk
102	Shri K. Jerald Raja	Upper Division Clerk
103	Smt. R. Anantharani	Lower Division Clerk
Madras R.C		
104	Smt. G. Abitha	Assistant Administrative Officer
105	Smt. P. Thankaleelal	Assistant
106	Smt. Leelavathi	Personal Assistant
107	Shri S. Yuvarajan	Upper Division Clerk
108	Smt. S. Anjalidevi	Lower Division Clerk
Karwar R.C		
109	Shri Ratan P. Naik	Lower Division Clerk
Vizhinjam R.C		
110	Smt. K. Latha	Assistant
111	Shri R. Balakrishnan	Lower Division Clerk
112	Smt. M.P. Kaladevi	Lower Division Clerk
Calicut R.C		
113	Shri R. Sreenivasan	Assistant
114	Smt. K.P. Shylaja	Assistant
115	Smt. K. Balamani	Assistant
116	Smt. N.G. Supriya	Assistant
117	Shri C.P. Umasankar	Lower Division Clerk
KVK, Narakkal		
118	Shri Augustus Julin Raj	Assistant
119	Smt. Rincy K.R.	Stenographer Grade III

SUPPORTING

Sl.No.	Name	Desigantion
CMFRI, Kochi		
1	Shri T.I. Soman	Skilled Support Staff
2	Shri S. Mohanan	Skilled Support Staff
3	Shri N.P. Mohanan	Skilled Support Staff
4	Shri K.C. Rajappan	Skilled Support Staff
5	Shri V.T. Ravi	Skilled Support Staff
6	Smt. A. Latha	Skilled Support Staff
7	Shri K.G. Jayaprasad	Skilled Support Staff
8	Shri T.K. Antony	Skilled Support Staff
9	Smt. K.T. Prakasini	Skilled Support Staff
10	Smt. P.K. Usha	Skilled Support Staff
11	Shri M.D. Suresh	Skilled Support Staff
12	Smt. Usha. S.	Skilled Support Staff
13	Shri V. Rajendran	Skilled Support Staff
14	Smt. P.K. Sujatha	Skilled Support Staff
15	Shri M.J. Joseph	Skilled Support Staff
16	Smt. Subaida. K.S.	Skilled Support Staff
17	Smt. S. Prasannakumari	Skilled Support Staff
18	Smt. K.S. Jeeji	Skilled Support Staff
19	Shri C.R. Mohanan	Skilled Support Staff
20	Smt. K. Parukutty	Skilled Support Staff
21	Shri Biju George	Skilled Support Staff
22	Shri T. Rajesh Babu	Skilled Support Staff
23	Shri P.M. Gireesh	Skilled Support Staff
24	Smt. T.R. Kumari	Skilled Support Staff
25	Shri Rajesh P.A	Skilled Support Staff
26	Shri Rajesh T.K	Skilled Support Staff
Mandapam R.C		
27	Shri S. Murugan	Skilled Support Staff
28	Shri V. Narasimhabharathi	Skilled Support Staff
29	Shri P. Ramu	Skilled Support Staff
30	Shri J. Hameed Sultan	Skilled Support Staff
31	Shri K. Thangavelu	Skilled Support Staff

32	Shri U. Rajendran	Skilled Support Staff
33	Shri K. Jeevanandam	Skilled Support Staff
34	Shri N. Nagamuthu	Skilled Support Staff
35	Smt. Subbulakshmi	Skilled Support Staff
36	Shri M. Saravana Kumar	Skilled Support Staff
37	Shri K. Anandan	Skilled Support Staff
38	Shri K. Ganesan	Skilled Support Staff
39	Shri K. Chandran	Skilled Support Staff
40	Shri N. Ramamoorthy	Skilled Support Staff
41	Smt. M. Saraswathi	Skilled Support Staff
42	Shri N. Thirupathi	Skilled Support Staff
43	Shri M. Jayasingh	Skilled Support Staff
44	Shri A. Bose	Skilled Support Staff
45	Shri K. Narayanan	Skilled Support Staff
46	Shri K. Krishnan	Skilled Support Staff
47	Smt. M. Muthuvelu	Skilled Support Staff
Visakhapatnam R.C		
48	Shri R. Kanaka Raju	Skilled Support Staff
49	Shri D. Lingaraju	Skilled Support Staff
50	Shri Oggu China Venkateswarlu	Skilled Support Staff
51	Shri S. Srinivasulu	Skilled Support Staff
52	Shri R. Pydi Raju	Skilled Support Staff
Veraval R.C		
53	Shri Haridas Khimdas Makwana	Skilled Support Staff
54	Shri Ladani Dhirajlal Jamnadas	Skilled Support Staff
55	Shri Sangabhai Lakhabhai Paredi	Skilled Support Staff
56	Smt. Santok A. Bharada	Skilled Support Staff
Mumbai R.C		
57	Shri S.M. Tandel	Skilled Support Staff
58	Shri K.K. Baikar	Skilled Support Staff
59	Shri D.D. Jangam	Skilled Support Staff
60	Smt. Urmila S. Balmiki	Skilled Support Staff
Karwar R.C		
61	Shri Subhash K. Naik	Skilled Support Staff
62	Shri Ramakant Shankar Harikantra	Skilled Support Staff
63	Shri Suresh Rumo Majalikar	Skilled Support Staff
64	Smt. Vijayalakshmi Y. Gamanagatti	Skilled Support Staff
65	Smt. Nandini Mayekar	Skilled Support Staff
66	Shri T.P. Renilkumar	Skilled Support Staff
Calicut R.C		
67	Shri P. Dassan	Skilled Support Staff
68	Shri M.K. Chandran	Skilled Support Staff
69	Shri K.T. Mohanan	Skilled Support Staff
70	Shri P. Satheeshkumar	Skilled Support Staff
71	Shri M.P. Devadasan	Skilled Support Staff
72	Shri P.V. Gopalan	Skilled Support Staff
73	Shri P.B. Jeevaraj	Skilled Support Staff
Mangalore R.C		
74	Shri U.B. Sadasiva	Skilled Support Staff
75	Shri A. Keshava	Skilled Support Staff
76	Shri S. Mahalinga Naik	Skilled Support Staff
Tuticorin RC		
77	Shri S. Alagesan	Skilled Support Staff
78	Shri I. Ravindran	Skilled Support Staff
79	Shri S. Mariappan	Skilled Support Staff
80	Shri M. Soundrapandian	Skilled Support Staff
81	Shri M. Kalimuthu	Skilled Support Staff
82	Shri K. Subramanian	Skilled Support Staff
83	Shri A. Paul Pondi	Skilled Support Staff
84	Smt. A. Usha Rani	Skilled Support Staff
85	Shri C.S. Santhanakumar	Skilled Support Staff
Vizhinjam R.C		
86	Shri B. Babu	Skilled Support Staff
87	Smt. T. Jayakumari	Skilled Support Staff
88	Shri S. Satheesh Kumar	Skilled Support Staff
Chennai R.C		
89	Shri A. Janakiraman	Skilled Support Staff
90	Shri G. Chakrapani	Skilled Support Staff
91	Shri P. Selvaraj	Skilled Support Staff
92	Shri S. Imbamani	Skilled Support Staff
93	Smt. R. Kalaiselvi	Skilled Support Staff
94	Shri R. Kumaran	Skilled Support Staff
95	Smt. R. Sarojini	Skilled Support Staff
96	Smt. M. Sundari	Skilled Support Staff
97	Smt. R. Eswari	Skilled Support Staff
KVK, Narakkal		
98	Shri K.M. Anilkumar	Skilled Support Staff

CANTEEN STAFF

Sl.No.	Name	Designation
CMFRI, Kochi		
1	Shri P.V. George	Canteen Attendant
2	Shri M.V. Devassykutty	Canteen Attendant
3	Shri P.K. Purushan	Canteen Attendant

RESEARCH PROJECTS

In- house 12th plan (2012-2017)

Sl.No	Project Code	Title of the Project	PI of the project & Division	Co-PIs	Duration	Total Cost (₹in Lakhs)	Location
1.	FISHCMFRISIL 201200100001	GIS based management advisory support information system for the marine fisheries sector	Dr.T.V. Sathianandan FRAD	Dr. J. Jayasankar Dr. Somy Kuriakose Dr. K.G. Mini Shri. Wilson T Mathew Dr. Grinson George	2012-2017	2822.00	Kochi
2.	FISHCMFRISIL 201200200002	Remote sensing assisted oceanologic biodynamic forecasting paradigm for Indian marine resources	Dr. J. Jayasankar FRAD	Dr. Somy Kuriakose Dr. K.G. Mini Shri. Wilson T Mathew Dr. Prathibha Rohit Shri.K.R. Sreenath Dr. Gyanaranjan Dash Smt.Anulakshmi Chellappan Shri.L. Ranjith Dr. B.Johnson Kum. Indira Divipala Shri. N. Rajendra Naik Dr. Grinson George Dr. Reeta Jayasankar Dr. G.B. Purushottama Dr. Bindu Sulochanan Dr. P.U. Zacharia Dr. P. Hemasankari Dr. Loveson Edward	2012-2017	454.68	Kochi Mangalore Mumbai Veraval Tuticorin Chennai Visakhapatnam
3	FISHCMFRISIL 201200300003	Development of fishery management plans for sustaining marine fisheries of Kerala and Lakshadweep	Dr. Rekha J. Nair DFD	Dr. P. U. Zacharia Dr. T. M. Najmudeen Dr. V. Venkatesan Dr. G. Maheswarudu Dr. Josileen Jose Dr. S. Lakshmi Pillai Dr. Rekha Devi Chakraborty Dr. E. M. Abdusammad Dr. U. Ganga Shri. K. P. Said Koya Dr. P. K. Asokan Dr. M.K. Anil Dr. K.N. Saleela Dr. B. Santhosh Dr. Somy Kuriakose	2012-2017	955.33	Kochi Calicut Vizhinjam
4.	FISHCMFRISIL 201200400004	Development of fishery management plans for sustaining marine fisheries of Gujarat	Shri. K. Mohammed Koya PFD	Smt. Swatipriyanka Sen Dr. Gyanaranjan Dash Shri. Vinay Kumar Vase	2012-2017	711.28	Veraval

5.	FISHCMFRISIL 201200500005	Assessment of elasmobranch resources in the Indian seas	Dr. Shoba Joe Kizhakudan DFD	Dr. P. U. Zacharia Dr. K. S. Sobhana Dr. T. M. Najmudeen Dr. Rekha. J. Nair Dr. P.P. Manojkumar Dr. Sujitha Thomas Smt. M. Muktha Dr. G. B. Purushottama Smt. Swaipriyanka Sen Dr. B. Santhosh Shri. R. Saravanan Shri. L.Ranjith	2012-2017	492.70	Chennai Kochi Vizhinjam Mangalore Mumbai Veraval Tuticorin Mandapam Visakhapatnam
6.	FISHCMFRISIL 201200600006	Development of fishery management plans for sustaining marine fisheries of Karnataka and Goa	Dr. Prathibha Rohit PFD	Dr. A. P. Dineshbabu Dr. Sujitha Thomas Dr. K.M. Rajesh Dr. Geetha Sasikumar Dr. P.S. Swathilekshmi Dr. Bindu Sulochanan Dr. K.G. Mini	2012-2017	447.50	Mangalore
7.	FISHCMFRISIL 201200700007	Development of strategies to sustain the stock and fishery of large pelagics in Indian waters	Dr. E.M. Abdussamad PFD	Shri. K.P. Said Koya Shri. K. Mohammed Koya Smt.Anulekshmi Chellappan Dr. Prathibha Rohit Dr. K.M. Rajesh Dr. U. Ganga Dr. S. Jasmine Dr. M. Sivadas Dr. A. Margaret Muthu Rathinam Dr. Shubhadeep Ghosh Dr. K.G. Mini	2012-2017	686.50	Kochi Calicut Vizhinjam Mangalore Mumbai Veraval Tuticorin Chennai Visakhapatnam
8.	FISHCMFRISIL 201200800008	Development of fishery management plans for sustaining marine fisheries of Tamil Nadu and Puducherry	Dr.M.Sivadas PFD	Dr. I. Jagdis Dr. P. T. Sarada Dr. Sobha Joe Kizhakkudan Dr. Margaret Muthu Rathinam Kum. Indira Divibala Dr. K. N. Saleela Dr. Grinson George Shri. R. Saravanan	2012-2017	450.638	Tuticorin Chennai Mandapam Vizhinjam
9.	FISHCMFRISIL 201200900009	GIS based resource mapping of distribution and abundance of finfishes and shellfishes off Indian coast for suggesting operational based strategies for fisheries management	Dr. A.P. Dinesh Babu CFD	Shri. K. Mohammed Koya Dr. Gyanranjan Dash Smt. Swatipriyanka Sen Smt.Anulekshmi Chellappan Dr. Prathibha Rohit Dr. Sujitha Thomas Dr. K. M. Rajesh Dr. Senthil Murugan Dr. P. P. Manojkumar Dr. Josileen Jose Dr. S. Lakshmi Pillai Dr. Rekha Devi Chakraborty Dr. T.M. Najmudeen Dr. K.N. Saleela Dr. P. T. Sarada Dr. M. Sivadas Dr.Shobha Joe Kizhakkudan Kum. Indira Divipala Dr. Shubhadeep Ghosh Smt. M. Muktha Shri. N. Rajendra Naik	2012-2017	795.88	Mangalore Karwar Mumbai Veraval Calicut Kochi Vizhinjam Tuticorin Chennai Visakhapatnam
10	FISHCMFRISIL 201201000010	Development of fishery management plans for sustaining marine fisheries of Maharashtra	Dr. V.V. Singh FEMD	Smt.Anulekshmi Chellappan Dr. G. B. Purushottama Shri. S. Ramkumar	2012-2017	1135.66	Mumbai

11.	FISHCMFRISIL 201201100011	Development of fisheries management plans for Sustaining marine fisheries of Andhra Pradesh	Smt. M. Muktha DFD	Dr. Shubhadeep Ghosh Shri. Loveson Edward Shri. N. Rajendra Naik Dr. Wilson T Mathew	2012-2017	589.20	Visakhapatnam
12.	FISHCMFRISIL 201201200012	Development of Fishery Management Plans (FMPs) for the bivalve fisheries of India.	Dr. Geetha Sasikumar MFD	Dr. I. Jagdis Dr. K. S. Mohamed Dr. V. Venkateshan Dr. P. K. Ashokan Dr. Reeta Jayasankar Dr. M.K. Anil	2012-2017	515.20	Mangalore Calicut Kochi Vizhinjam Tuticorin Visakhapatnam
13.	FISHCMFRISIL 201201300013	Evaluation of ornamental gastropod fisheries in India and assessment of shell craft industry	Dr. I. Jagadis MFD	Dr. V. Venkatesan Dr. Shyam. S. Salim Shri. C. Kalidas	2012-2015	166.96	Tuticorin Kochi
14.	FISHCMFRISIL 201201400014	Sustainable molluscan mariculture practices	Dr.P.K. Asokan MFD	Dr. K. S. Mohamed Dr. I. Jagdis Dr. Geetha Sasikumar Dr. M. K. Anil Dr. V. Kripa Dr. P. Kaladharan Dr. V.P. Vipinkumar	2012-2017	408.30	Calicut Kochi Vizhinjam Mangalore Tuticorin
15.	FISHCMFRISIL 201201500015	Bioinventorying and biodiversity valuation of marine organisms in selected marine ecosystems along the Indian coast	Dr. K.K. Joshi MBD	Dr. P. Laxmilatha Dr. Molly Varghese Dr. S. Jasmine Dr. R. Narayanakumar Shri. K.R. Sreenath Shri. R. Saravanan Shri.L. Renjith Shri. Pralaya Ranjan Behera Shri.S. Ramkumar	2012-2017	460.00	Kochi Vizhinjam Mumbai Veraval Tuticorin Mandapam Visakhapatnam
16.	FISHCMFRISIL 201201600016	Investigations on vulnerable coral reef ecosystems of Indian waters with special emphasis on formulation of management measures for conservation	Dr. Rani Mary George MBD	Dr. S. Jasmine Dr. K. Vinod Dr. Molly Varghese Dr. K.S. Sobhana Shri. K.R. Sreenath Shri. R. Saravanan Shri. L.Ranjith Shri. Pralaya Ranjan Behera Shri. S. Ramkumar	2012-2017	645.70	Vizhinjam Kochi Calicut Veraval Tuticorin Mandapam Chennai Visakhapatnam
17.	FISHCMFRISIL 201201700017	Assessment of fishing impacts on biodiversity loss, with special reference to the threatened species, to formulate management options for their protection	Dr.K.Vinod MBD	Dr. K.K. Joshi Dr. Molly Varghese Dr. S. Jasmine Shri. K. R. Sreenath Shri. R. Saravanan Shri. L. Ranjith Shri. Pralaya Ranjan Behara Shri. S. Ramkumar Dr. R. Geetha	2012-2015	280.803	Calicut Kochi Vizhinjam Mumbai Veraval Tuticorin Mandapam Chennai Visakhapatnam
18.	FISHCMFRISIL 201201800018	Ecosystem process of critical marine habitats and development of protocols for restoration	Dr.V.Kripa FEMD	Dr. D. Prema Dr. R. Jayabhaskaran Dr. P. Kaladharan Dr. Bindhu Sulochanan Dr. V. V. Singh Dr. P. S. Asha Smt. P. Hemasankari Shri. Loveson Edward Dr. Geetha Sasikumar Dr. K. Vijayakumaran	2012-2017	1095.00	Kochi Calicut Mangalore Mumbai Tuticorin Chennai Visakhapatnam

19.	FISHCMFRISIL 201201900019	Pollution and litter in the coastal and marine ecosystem and their impact	Dr.P.Kaladharan FEMD	Dr. V. Kripa Dr. D. Prema Dr. R. Jayabaskaran Dr. Bindhu Sulochanan Dr. V. V. Singh Dr. P. S. Asha Smt. P. Hemasankari Shri. Loveson Edward Dr. K. Vijayakumaran	2012-2017	1337.70	Kochi Mangalore Mumbai Tuticorin Chennai Visakhapatnam
20.	FISHCMFRISIL 201202000020	Economics of marine fisheries and sustainable management: Policy Issues and Interventions	Dr.R.Narayanakumar SEETTD	Dr. M. S. Madan Dr. C. Ramachandran Dr. Shyam. S. Salim Dr. P. S. Swathilekshmi Dr. N. Aswathy Dr. R. Geetha Dr. B. Johnson	2012-2017	237.00	Kochi Mangalore Tuticorin Mandapam Chennai
21.	FISHCMFRISIL 201202100021	An input output economic optimisation model for marine fisheries at Tuticorin Fishing Harbour	Dr. M.S. Madan SEETTD	Dr. N. Aswathy Dr. M. Sivadas Shri. L. Ranjit	2012-2015	72.01	Tuticorin Kochi
22.	FISHCMFRISIL 201202200022	Capacity development for Ecosystem Based Responsible Fisheries Management in India- A co-learning action research	Dr.C.Ramachandran SEETTD	Dr. V.P Vipinkumar Dr. P. S. Swathilakshmi Dr. B. Johnson	2012-2017	103.75	Kochi Mangalore Mandapam
23.	FISHCMFRISIL 201202300023	Supply chain management of marine fisheries sector In India	Dr. Shyam.S.Salim SEETTD	Dr. R. Narayanakumar Dr. M. S. Madan Dr. T. V. Sathianandan Dr. V.P.Vipinkumar Dr. N. Aswathy Dr. R. Geetha Dr. B. Johnson	2012-2017	239.72	Kochi Tuticorin Mandapam Chennai
24.	FISHCMFRISIL 201202400024	Development and standardisation of seed production technologies for selected high value finfishes and shellfishes	Dr. A.K Abdul Nazar MD	Dr. R. Jayakumar Dr. G. Tamilmani Dr. M. Sakthivel Dr. P. Rameshkumar Shri. C. Kalidas Dr. K. Madhu Dr. Rema Madhu Dr. Boby Ignatius Dr. Imelda Joseph Dr. Shoji Joseph Dr. Ritesh Ranjan Smt. Biji Xavier Dr. B. Santhosh Dr. K.K. Philipose Dr. Jayashree Loka Dr. T. Senthil Murugan Dr. Krupesha Sharma Dr. D. Divu Dr. Joe K. Kizhakudan Dr. Gulshad Mohammed Shri. Loveson Edward Shri. Pralaya Ranjan Behera	2012-2017	3621.85	Mandapam Tuticorin Chennai Visakhapatnam Kochi Vizhinjam Calicut Karwar Veraval
25.	FISHCMFRISIL 201202500025	Innovations in sea cage farming and coastal mariculture	Dr.K.K.Philipose MD	Dr. Jayasree Loka Dr. Senthil Murugan Dr. Krupesha Sharma Dr. D. Divu Dr. G. Gopakumar Dr. A.K. Abdul Nazar Dr. R. Jayakumar	2012-2017	2304.40	Karwar Veraval Mangalore Kochi Calicut Vizhinjam Tuticorin

				Dr. G. Tamilmani Dr. P. Ramesh Kumar Dr. M. Saktivel Shri. C. Kalidas Dr. B. Johnson Dr. Ritesh Ranjan Smt. Biji Xavier Dr. Rema Madhu Dr. K. Madhu Dr. Boby Ignatius Dr. Imelda Joseph Dr. Shoji Joseph Dr. N. Aswathy Dr. A.P Dinesh Babu Dr. Sujitha Thomas Dr. Joe K. Kizhakudan Shri. K. Mohammed Koya Dr. Gulshad Mohammed Dr. P.P. Manoj Kumar Dr. Reeta Jayasankar Dr. B. Santhosh			Mandapam Chennai Visakhapatnam
26.	FISHCMFRISIL 201202600026	Health Management in selected finfish and shellfish for mariculture and aquariculture & bioprospecting from marine resources	Shri. N. K. Sanil MBTD	Dr. P. Vijayagopal Dr. A.P. Lipton Dr. Kajal Chakraborty Dr. M. A. Pradeep Dr. Sandhya Sukumaran Dr. P. K. Asokan Dr. I. Rajendran Dr. Krupesha Sharma Dr. Jayasree Loka Dr. M. K. Anil Dr. Joe K. Kizhakudan Dr. Vidya Jayasankar Dr. V. Srinivasa Raghavan Dr. Rithesh Ranjan Dr. P. Ramesh Kumar	2012-2017	1026.00	Kochi Vizhinjam Calicut Karwar Mandapam Chennai Visakhapatnam
27.	FISHCMFRISIL 201202700027	Aquatic feed biotechnology for mariculture and aquariculture	Dr. P. Vijayagopal MBTD	Dr. I. Rajendran Dr. M. A. Pradeep Dr. M. K. Anil Dr. Joe K. Kizhakudan Dr. Boby Ignatius Dr. Krupesha Sharma Dr. Vidya Jayasankar Dr. Kajal Chakraborty Shri. C. Kalidas	2012-2017	1356.00	Kochi Vizhinjam Karwar Mandapam Chennai
28	FISHCMFRISIL 201202800028	Genetics, genomics and biotechnological applications in mariculture and fishery resources management	Dr. A. Gopalakrishnan	Dr. Sandhya Sukumaran Dr. Vidya Jayasankar Dr. V. Srinivasa Raghavan Dr. M. A. Pradeep Dr. Joe K. Kizhakudan Dr. P. Kaladharan Dr. C.P. Suja	2012-2017	394.50	Kochi Chennai Tuticorin
29	FISHCMFRISIL 201202900029	Development of tissue culture technology for in vitro production of pearls from the blacklip pearl oyster *Pinctada margaritifera* and refinement of in vitro pearl formation in *Pinctada fucata*	Dr. C.P. Suja MBTD	Dr. Vidya Jayasankar Dr. V. Srinivasa Raghavan Kum. Indira Divipala	2012-2015	351.00	Tuticorin Chennai

30.	FISHCMFRISIL 201203000030	Integrated approaches for improving the reproductive performance of selected marine food fishes	Dr. D. Divu MD	Dr. Senthil Murugan Dr. Jayasree Loka	2012-2015	74.89	Karwar
31.	FISHCMFRISIL 201203100031	Derivation and characterisation of embryonic (ES) and induced pluripotent (iPS) stem cell lines from selected marine fish species aimed at mariculture/conservation	Dr. K.S. Sobhana MBD	Dr. K. Madhu Dr. Rema Madhu Shri. C. Kalidas Dr. M. Sakthivel	2012-2017	144.00	Kochi Mandapam Tuticorin
32.	FISHCMFRISIL 201203200032	Trawl fishery of the North east coast of India: An appraisal	Dr. Shubhadeep Ghosh PFD	Dr. Reeta Jayasankar Smt. M. Muktha Shri. Pralaya Ranjan Behera Shri. N. Rajendra Naik	2012-2015	101.70	Visakhapatnam
33.	FISHCMFRISIL 201400100033	Assessment and valuation of Coral reef Island ecosystem	Dr. P. Laxmilatha MBD	Dr. R. Narayanakumar Dr. S. Jasmine Sri. K.R. Sreenath Shri. R. Saravanan Shri. Pralaya Ranjan Behera Shri. L. Ranjith Shri. S. Ramkumar	2014- 2017	169.00	Kochi Vizhinjam Karwar Mumbai Veraval Tuticorin Mandapam Visakhapatnam
34.	FISHCMFRISIL 201400200034	Resource assessment, exploitation and utilisation of marine algae from Indian coasts.	Dr. P. Kaladharan FEMD	Dr. Reeta Jayasankar Dr. B. Johnson Shri. Loveson Edward	2014-2017	121.2	Kochi Mandapam Visakhapatnam
35.	FISHCMFRISIL 201400300035	Gender mainstreaming and Impact of self-help groups in marine fisheries sector.	Dr. V.P. Vipin Kumar SEETTD	Dr. R. Narayanakumar Dr. C. Ramachandran Dr. P.S. Swathilakshmi Dr. Shyam. S. Salim Dr. N. Aswathy Dr. B. Johnson Dr. Shinoj Subrammannian Dr. Reeta Jayasankar	2014- 2017	70.00	Kochi Mangalore Mandapam Visakhapatnam

RESEARCH PROJECTS

Externally Funded

Sl. No.	Project Title	PI
1	Commercial viability of black pearl production in the A&N Islands and Conservation mariculture of ETP gastropods - **(MoES- CMLRE)**	Dr. K.S. Mohammed
2	Assessment of deep-sea fishery resources of the continental slope of the Indian EEZ - **(MoES-CMLRE)**	Dr. U. Ganga
3	Resources assessment and barcoding of elasmobranchs - **(MoES-CMLRE)**	Dr. P.U. Zacharia
4	National Initiative on Climate Resilient Agriculture (NICRA) - **(DARE- ICAR)**	Dr. P.U.Zacharia
5	Global learning for local solution: Reducing vulnerability of marine dependent coastal communities - **(Belmont Forum through MoES)**	Dr. A. Gopalakrishnan
6	State of diversity of commercially important seaweeds along the west coast of India **(ICAR-NFBSFARA)**	Dr. V.V. Singh
7	Stock characterisation, captive breeding, seed production and culture of hilsa (*Tenualosa ilisha*) - **(ICAR- NFBSFARA)**	Dr. Ritesh Ranjan
8	Towards developing models for prediction of recruitment success in major Indian marine fish stocks - **(MoES- CMLRE)**	Dr. V. Kripa
9	Eco-biological investigations on major pelagic fishes and ecobiological modeling of the epipelagic habitat off Kerala and Lakshadweep - **(MoES-INCOIS)**	Dr. V. Kripa
10	Satellite telemetry studies for understanding environmental preferences and migratory patterns of yellowfin tuna, *Thunnus albacares* in the Indian Ocean - **(MoES- INCOIS)**	Dr. Prathibha Rohit
11	Seed production of marine food fishes and ornamental fishes - **(ICAR- Revolving Fund)**	Dr. K. Madhu
12	Mapping and resource assessment of pearl oyster banks of Tuticorin(Central) division of Gulf of Mannar - **(MoEF)**	Dr. I. Jagadis
13	Integrative taxonomy of deep sea shrimp resources along the southern coast of India - **(DST)**	Dr. Rekhadevi Chakraborty
14	National surveillance programme for aquatic animal diseases - **(NFDB)**	Shri N.K. Sanil

15	Development of protocols and capacity building on stranding beaching and post-mortum analysis of Cetaceans- **(GOI-UNDP-GEF)**	Dr. M. Sakthivel
16	Flow of matter through trophic levels and biogeochemical cycles in marine and estuarine ecosystems **(MoES)**	Dr. Sujitha Thomas
17	ICAR Outreach activity on fish feeds - **(ICAR Outreach)**	Dr. P. Vijayagopal
18	Value adding the marine gastropod fisheries in molluscs for nutraceutical development India and Australia: Sustainable mariculture and strategic research into Muricidae - **(DST-AISRF)**	Dr. P. Vijayagopal
19	Polyunsaturated fatty acid enriched formulations from locally available low value fish and fishery by-catch for use as nutraceuticals and aquafeed supplementes - **(DST)**	Dr. Kajal Chakraborty
20	Nutrient profiling and evaluation of fish as a dietary component - **(ICAR-Outreach)**	Dr. Kajal Chakraborty
21	Development of antimicrobial, anti-inflammatory and anticancer agents from the marine organisms and micro-organisms - **(MoES)**	Dr. Kajal Chakraborty
22	Characterization of polysaccharides and phenolics from marine macroalgae as defense metabolites against oxidative stress and inflammation - **(DST)**	Dr. Kajal Chakraborty
23	Phytochemicals/High value compounds - **(ICAR-PLATFORM)**	Dr. Kajal Chakraborty
24	Genetic study on the breeding stock of Indian mackerel - **(BOBLME)**	Dr. Sandhya Sukumaran (Co PI)
25	Molecular approach to diet analysis in selected commercially important tunas - **(SERB-DST)**	Dr. Sandhya Sukumaran
26	Outreach activity on fish genetic stocks - **(ICAR Outreach)**	Dr. P. Vijayagopal
27	Capacity building on seed production of selected marine ornamental fishes to fisherwomen in Gulf of Mannar Region - **(GoMBRT)**	Dr. B. Johnson
28	Living resources of the Gulf of Mannar: Assessment of key species and habitats for enhancing awareness and for conservation policy formulation - **(IUCN-MFF)**	Dr. R. Jeyabaskaran
29	Participatory management for conservation of seahorses in the Gulf of Mannar, south-east coast of India - **(BOBLME)**	Dr. K. Vlnod
30	An evaluation of the current conservation measures on sea cucumber stocks in Palk Bay and Gulf of Mannar - **(BOBLME)**	Dr. P.S. Asha
31	A study on the estimation of input cost of marine fishery (including prawns and high valued fish for arriving at Gross Value Added (GVA) - **(MoSPI-CSO)**	Dr. R. Narayanakumar
32	Determination of the conservation value of the mangroves of Kerala : Resource assessment, economic evaluation and geo-referencing of mangrove patches along Kerala coast -**(NCSCM)**	Dr. Grinson George
33	Demonstration of bivalve farming at Sindhudurg District in the state of Maharashtra - **(UNDP-GEF)**	Dr. P.K. Asokan
34	Strategies to enhance adaptive capacity to climate change in vulnerable regions - World Bank - **(NAIP- GEF)**	Dr. V. V. Singh
35	Application of remote sensing to study of structure and function of marine ecosystem, including fisheries - **(Jawaharlal Nehru Fellowship - SERB - DST)**	Dr. Trevor Charles Platt Dr. Grinson George

CONSULTANCY PROJECTS

2014-2015

No.	Client	Project title	PI	Status	Amount (lakhs)
1006269	The Project Director, International Fund for Agriculture Development (IFAD) assisted Post Tsunami Sustainable Livliehood Programme (PTSLP) Tamil Nadu Corporation for Development of Women (TNCDW)100 Anna Salai Rd, Guindy, Chennai	Consultancy on artificial reefs in inshore waters of two districts of Tamil Nadu	Shoba Joe Kizhakkudan	Part II in progress	7.93
1006270	The Project Director IFAD assisted PTSLP TNCDW 100 Anna Salai Rd, 0Guindy, Chennai	Consultancy on artificial reefs in inshore waters of four districts of Tamil Nadu	Shoba Joe Kizhakkudan	Part II in progress	19.90
1006919	Commissioner of Fisheries, Dept. of Fisheries, Govt. of Tamil Nadu (TN)	Installation of artificial reefs in inshore waters of two villages in Kancheepuram District of Tamil Nadu	Shoba Joe Kizhakkudan	Part II in progress	30.00
1006718	Director of Fisheries, Dept. Of Fisheries,TN	Installation of artificial reefs in the inshore waters of seventeen villages along Tamil Nadu coast	Margaret Muthu Rethinam A	In progress	260.80.
1005842	Koteswara Rao, Joint Director of Fisheries, Visakhapatanam, Andhra Pradesh (AP)	Installation of artificial reef at a selected site off Visakhapatnam, Andhra Pradesh	Loveson Edward	In progress	30.32
1002796	Mr. Edgar Endrukaitis,Director,Biodiversity Programme,A-2/18, Safdarjung Enclave, New Delhi – 110 029	Assessment of eco-labeling as tool for conservation and sustainable use of biodiversity in Ashtamudi Lake, Kerala (Southwest coast of India)	K.Sunil Mohamed	In progress	36.77
1002520	MD, Vision Varkala Infrastructure Development Corporation (VVIDC) Ltd.,Thiruvanathapuram	Pre-feasibility study of Sea Life leisure Park at Kappil, Varkala	M.K. Anil	In progress	1.98
1006299	Program Director, Management of Coastal and marine protected areas, Biodiversity program office, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), New Delhi	Study on enhancing the effectiveness of conservation potential of marine mammals in Indian seas	R. Jeyabaskaran	In progress	15.41
1006469	The Project Director, IFAD assisted PTSLP, TNCDW,100 Anna Salai Rd, Guindy, Chennai	Consultancy on livelihood enhancement of fishermen through deployment of AR in inshore waters along the six districts of TN	Joe K. Kizhakudan	In progress	92.98
1006655	M/s JSW Infrastructure Limited, JSW Centre, Bandra Kurla Complex, Bandra (East), Mumbai	Assessment of impact on fish production due to development of all weather captive jetty at Nandgaon, Maharashtra	V. V. Singh	In progress	68.59
				TOTAL	**564.68**

RESULTS FRAMEWORK DOCUMENT 2014-15

Annual (April 1, 2013 to March 31, 2014) Performance Evaluation Report in respect of RFD of RSC's for the year 2013-2014

Name of the Institute: Central Marine Fisheries Research Institute, Cochin

RFD Nodal Officer: Dr.R.Narayanakumar, Principal Scientist & Head, SEETT Division

S. No.	Objective (s)	Weight	Action(s)	Success Indicator(s)	Unit	Weight	Target / Criteria Value					Achievements	Performance		Percent achievements against Target values of 90% Col.	Reasons for shortfalls or excessive achievements, if applicable
							Excellent 100%	Very Good 90%	Good 80%	Fair 70%	Poor 60%		Raw Score	Weighted Score		
01	Marine Fishery Resources Assessment	62	Compilation of chlorophyll and other plankton abundance data using remote sensing and in situ observations for forecasting Indian marine fishery resources	Development of grid-wise time series data base on chlorophyll abundance, marine catch, effort and catch rate with geo reference tags	Number of grids	4.00	09	08	06	05	04	09	100	4.00	112.50	All targets achieved
				Estimation of spatio-dynamic model components for the study area	Number of components	3.00	05	04	03	02	01	05	100	3.00	125.00	All targets achieved
			Assessment of marine fishery resources of the country and strengthening of the National Marine Fisheries Informatio n System	Estimation of Marine fish landings and data base updation	Date	14.0 0	27.03. 14	28.03 .14	29.03 .14	30.0 3.14	31.0 3.14	27.3.14	100	14.00	111.1	Database updated and presented in time
			Formulatio n and disseminati on of regional marine fisheries manageme nt plans	Rapid assessment of the status of exploited stocks, in maritime states	Number of stocks	10.0 0	28	26	24	22	20	28	100	10.00	107.69	All targets achieved
			Establish ment of a National Fisheries Grid-GIS Platform	Development of regional spatio-temporal resource mapping of distribution and abundance of fishes off	Number of fish species	7.00	20	18	16	14	12	20	100	7.00	111.10	All targets achieved
			Bio- inventoryin g and biodiversity evaluation of marine ecosystem	Development of GIS based data base and valuation of marine organisms	Number of species	8.00	28	26	24	22	20	28	100	8.0	107.69	All targets achieved

			Ecosystem monitoring	Environmental impact parameters in hydrographic and benthic ecosystems	Number of parameters	8.00	27	26	25	24	23	27	100	8.0	103.85	All targets achieved
			Socio- economic evaluation of marine fisheries sector	Estimation of indicators of socio-economic development and marketing efficiency in marine fisheries	Number of indicators	8.00	15	12	10	8	6	16	100	8.00	133.33	One additional indicator estimated
02	Productivity and production enhancement through mariculture	12	Fish seed production through mariculture	Production of marine finfish seedlings	Numbers (in' 00 0)	12.0 0	32	30	28	26	24	147	100	12.00	490.00	Intensive spawning during July to September
3	Transfer of technolog y, training & consultanc y services	15	Technolog y transfer	Process and product commercialization	Number	1.00	2	1	0	0	0	0	0	0	0	Process / Products-Nil
				Consultancy services	Number of clients	3.00	8	5	4	3	2	8	100	3.00	160.00	All targets achieved
				Analytical and advisory services	Number of clients	1.00	80	70	60	50	40	80	100	1.0	114.29	All targets achieved
				Training	Number of trainees	10.0 0	700	650	600	550	475	818	100	10.00	125.84	Additional trainings were conducted based on requests from stakeholders
	Efficient Functioning of the RFD System	03	Timely submission of Draft RFD (2013-14) for approval	On-time submission	Date	2.00	15.5.13	16.5.13	17.5.13	20.5.13	21. 5.13	13.5.13	100	2.00		
			Timely submission of Results for RFD (2012-13)	On-time submission	Date	1.00	1.5.13	2.5.13	5.5.13	6.5.13	7/.5.13	11.4.13	100	1.00		
	Administrative Reforms	04	Implement ISO 9001 as per the approved action plan	% Implementation	%	2.00	100	95	90	85	80	95	90	1.80		
			Prepare an action plan for Innovation	On-time submission	Date	2.00	30.7.13	10.8.13	20.8.13	30.8.13	10.9.13	31.7.13	99	1.98		
	Improving internal efficiency / responsiveness / service delivery of Ministry / Department	04	Implement ation of Sevottam	Independent Audit of Implementation of Citizen's Charter	%	2.00	100	95	90	85	80	100%	100	2.00		
				Independent Audit of implementation of public grievance redressal system	%	2.00	100	95	90	85	80	100%	100	2.00		
Total Composite Score: 98.78 Rating: Excellent Procedure for computing the Weighted and Composite Score Weighted Score of a Success Indicator = Weight of the corresponding Success Indicator x Raw Score / 100 Total Composite Score = Sum of Weighted Scores of all the Success Indicators																

Results-Framework Document (RFD)
for

Central Marine Fisheries Research Institute
(2014-2015)

Address P.B. No.1603, Ernakulam North P.O., Kochi-682 018, Kerala

Website ID http://www.cmfri.org.in

Section 1: Vision, Mission, Objectives and Functions

Vision

Sustainable marine fisheries through management interventions and enhanced coastal fish production through mariculture for improved coastal livelihood.

Mission

To develop information based management system for changing over from open access to regulated regime in marine fisheries, augment coastal fish production through mariculture and sea ranching and restore critical marine habitats**.**

Objectives

1. Marine fishery resources assessment
2. Productivity and production enhancement through mariculture
3. Transfer of technology, training and consultancy services

Functions

1. To monitor the exploited and assess the under-exploited stock of the marine fisheries resources of the Exclusive Economic Zone (EEZ)

2. To understand the fluctuations in abundance of marine fisheries resources in relation to change in the environment

3. To develop suitable mariculture technologies for finfish, shellfish and other culturable organisms in open seas to supplement capture fishery production

4. To act as a repository of information on marine fishery resources with a systematic data base

5. To conduct transfer of technology, post-graduate and specialized training, education and extension-education programmes

6. To provide consultancy services

Section 2: *Inter se* priorities among Key Objectives, Success Indicators and Targets

Sl. No.	Objectives	Weight	Actions	Success Indicators	Unit	Weight	Target / Criteria Value				
							Excellent	Very Good	Good	Fair	Poor
							100%	90%	80%	70%	60%
1	Marine fishery resources assessment	53	Compilation of chlorophyll and other plankton abundance data using remote sensing and *in situ* observations for forecasting Indian marine fishery resources	Development of grid-wise time series data base on chlorophyll abundance, marine catch, effort and catch rate with geo reference tags	Number of grid-months	3.00	81	72#	63	54	45
				Validation of satellite based Level-3 products for selected grids with relevant *in-situ* measurement	Number of grids	2.00	09**	08	06	04	02
			Assessment of marine fishery resources of the country and strengthening of the National Marine Fisheries Information System	Estimation of Marine fish landings and data base updating for the year 2014	Date	14.00	25.03.15@	27.03.15@	29.03.15	30.03.15	31.03.15
			Formulation and dissemination of regional marine fisheries management plans	Rapid assessment of the status of exploited stocks, in maritime states and publication of policy briefs	Number of stocks	8.00	36	30	24	18	12

			Establishment of a National Fisheries Grid-GIS Platform	Development of regional spatio-temporal resource mapping of distribution and abundance of fishes off Indian coast	Number of fish species@	5.00	26	22	18	14	10
			Bio-inventorying and biodiversity evaluation of marine ecosystem	GIS based database for valuation of marine organisms such as coral and fish species	Number of species	5.00	34	28	22	16	10
			Ecosystem monitoring	Number of environmental impact parameters in hydrographic and benthic ecosystems	Number	6.00	32	27	22	17	12
				Number of surveys conducted to assess the heath of the eco-system	Number	4.00	84	70	56	42	28
			Socio-economic evaluation of marine fisheries sector	Estimation of indicators/indices of socio-economic development and marketing efficiency in marine fisheries	Number	6.00	19	16	13	10	07
2	Productivity and production enhancement through mariculture	14	Fish seed production through hatchery trials	Production of marine finfish seedlings	Numbers (in'000)	14.00	72	60	48	36	24
3	Transfer of	13	Technology	Process and product	Nu	1.00	2	1	0	0	0

	technology, training and consultancy services		transfer	commercialization	mber						
				Consultancy services	Number of clients	2.00	6	5	4	3	2
				Analytical and advisory service	Number of clients	1.00	102	85	68	51	34
			Training	Number of trainees	Number	9.00	900	750	600	450	300
	Publication/Documentation	5	Publication of the research articles in the journals having the NAAS rating of 6.0 and above	Research articles published	No.	3	42	35	28	21	14
			Timely publication of the Institute Annual Report (2013-2014)	Annual Report published	Date	2	30.06.2014	02.07.2014	04.07.2014	07.07.2014	09.07.2014
	Fiscal resource management	2	Utilization of released plan fund	Plan fund utilized	%	2	98	96	94	92	90
	Efficient Functioning of the RFD System	3	Timely submission of Draft RFD for 2014-2015 for Approval	On-time submission	Date	2	May 15, 2014	May 16, 2014	May 19, 2014	May 20, 2014	May 21, 2014
			Timely submission of Results for 2013-2014	On-time submission	Date	1	May 1 2014	May 2 2014	May 5 2014	May 6 2014	May 7 2014

	Enhanced Transparency / Improved Service delivery of Ministry/Department	3	Rating from Independent Audit of implementation of Citizens' / Clients' Charter (CCC)	Degree of implementation of commitments in CCC	%	2	100	95	90	85	80
			Independent Audit of implementation of Grievance Redress Management (GRM) system	Degree of success in implementing GRM	%	1	100	95	90	85	80
	Administrative Reforms	7	Update organizational strategy to align with revised priorities	Date	Date	2	Nov.1 2014	Nov.2 2014	Nov. 3 2014	Nov. 4 2014	Nov. 5 2014
			Implementation of agreed milestones of approved Mitigating Strategies for Reduction of potential risk of corruption (MSC)	% of implementation	%	1	100	90	80	70	60
			Implementation of agreed milestones for ISO 9001	% of implementation	%	2	100	95	90	85	80
			Implementation of milestones of approved Innovation Action Plans (IAPs)	% of implementation	%	2	100	90	80	70	60

*Note: # This project commenced from 2013-14 only. The indicator is **grid month.** There are 9 grids and data collation will be for 9 months. Therefore, the maximum grid months expected is 9*9=81 grid months. Therefore, the indicators will be in multiples of 9.*
*** Maximum number of grid selected is '9'.*
@Data will be ready only by 3rd week of March. Hence the earlier indicators are retained.

Section 3: Trend Values of the Success Indicators

Sl. No.	Objectives	Actions	Success Indicators	Unit	Actual Value for FY 12/13	Actual Value for FY 13/14	Target Value for FY 14/15	Projected Value for FY 15/16	Projected Value for FY 16/17
1.	Marine fishery resources assessment	Compilation of chlorophyll and other plankton abundance data using remote sensing and *in-situ* observations for forecasting Indian marine fishery resources	Development of grid-wise time series data base on chlorophyll abundance, marine catch, effort and catch rate with geo reference tags	Number of grid-months#	Nil	9 grids	72#	81#	81#
			Validation of satellite based Level-3 products for selected grids with relevant *in-situ* measurement	Number of grids	Nil	Nil	8**	9**	**9****
		Assessment of marine fishery resources of the country and strengthening of the National Marine Fisheries Information System	Estimation of Marine fish landings and data base updating for the year 2014	Date	27.03.13	27.03.14	27.3.15	27.3.16	27.3.17
		Formulation and dissemination of regional marine fisheries management plans	Rapid assessment of the status of exploited stocks, in maritime states and publication of policy briefs	Number of stocks	24	28	30	34	36

		Establishment of a National Fisheries Grid-GIS Platform	Development of regional spatio-temporal resource mapping of distribution and abundance of fishes off Indian coast	Number of fish species	5@ centres	20 Species from 13-14	22	24	26
		Bio-inventorying and biodiversity evaluation of marine ecosystem	GIS based database for valuation of marine organisms such as coral and fish species	Number of species	20	26	28	30	36
		Ecosystem monitoring	Number of environmental impact parameters in hydrographic and benthic ecosystems	Number	25	26	27	28	30
			Number of surveys conducted to assess the heath of the eco-system	Number	50	63	**70**	75	77
		Socio-economic evaluation of marine fisheries sector	Estimation of indicators/indices of socio-economic development and marketing efficiency in marine fisheries	Number	8 States	16 indicators from 13-14	16	17	17

2.	Productivity and production enhancement through mariculture	Fish seed production through hatchery trials	Production of marine finfish seedlings	Numbers (in'000)	22	147* The spawning was very high during July to September	60	65	70
3.	Transfer of technology, training & consultancy services	Technology transfer	Process and product commercialization	Number	1	1	1	1	1
			Consultancy services	Number of clients	02	06	**05**	05	05
			Analytical and advisory service	Number of clients	65	80	85	90	100
		Training	Number of trainees	Number	444	818	750	800	840

	Publication/Documentation	Publication of the research articles in the journals having the NAAS rating of 6.0 and above	Research articles published	Number.	30	34	35	40	45
		Timely publication of the Institute Annual Report (2013-2014)	Annual Report published	Date	–	–	02.07. 2014	–	–
	Fiscal resource	Utilization of released plan fund	Plan fund utilized	%		–	96	–	–

	management								
	Efficient Functioning of the RFD System	Timely submission of Draft RFD for 2014-2015 for Approval	On-time submission	Date	-	-	May 16, 2014	_	_
		Timely submission of Results for 2013-2014	On-time submission	Date	-	-	May 2, 2014	_	_
	Enhanced Transparency / Improved Service delivery of Ministry/Department	Rating from Independent Audit of implementation of Citizens' / Clients' Charter (CCC)	Degree of implementation of commitments in CCC	%	-	-	95	_	_
		Independent Audit of implementation of Grievance Redress Management (GRM) system	Degree of success in implementing GRM	%	-	-	95	_	_
	Administrative Reforms	Update organizational strategy to align with revised priorities	Date	Date	-	-	Nov.2, 2014	_	_
		Implementation of agreed milestones of approved Mitigating Strategies for Reduction of potential risk of corruption (MSC)	% of implementation	%	-	-	90	_	_
		Implementation of agreed milestones for ISO 9001	% of implementation	%	-	-	95	_	_

		Implementation of milestones of approved Innovation Action Plans (IAPs)	% of implementation	%	-	-	90	–	–

*Note: # This project commenced from 2013-14 only. The indicator is **grid month.** There are 9 grids and data collation will be for 9 months. Therefore, the maximum grid months expected is 9*9=81 grid months. Therefore, the indicators will be in multiples of 9.*

@ This project commenced from 2012-13. Initially the unit was number of centres covered, later changed to number of species covered from 2013-14 onwards.

** The seed production commenced from 2012-13 only*

*** The project commenced from 2013-14 and this indicator was included during the current year only. Hence there is no previous value.*

Section 4(a): Acronyms

Sl.No.	Acronym	Description
01	EEZ	Exclusive Economic Zone
02	GIS	Geographical Information System
03	DAHD &F	Department of Animal Husbandry, Dairying and Fisheries
04	SAC	Space Applications Centre
05	NFDB	National Fisheries Development Board

Section 4(b): Description and definition of success indicators and proposed measurement methodology

Sl. No.	Success Indicator	Description	Definition	Measure-ment	General Comments
1	Development of grid-wise time series data base on chlorophyll abundance, marine catch, effort and catch rate with geo reference tags	A time series data base on various components like chlorophyll abundance from identified grids will be collected	A time series data base will be identified for each grid	For 9 grids in each sample month, time series data will be developed. The unit is grid months	Compilation of these information using remote sensing will assist in forecasting Indian marine fishery resources
2	Validation of satellite based Level-3 products for selected grids with relevant *in-situ* measurement	The data collected using satellite information and our sample data will be analyzed for validation	The satellite based data will be combined with *in-situ* observation for the selected grids	Number of grids	Validated Level-3 products will be used for grid wise database development
3	Estimation of Marine fish landings and data base updating for the year 2014	The marine fish landings in the country across the maritime states are assessed	The marine fish landings is estimated by collecting data on fish catch and effort from sample fishing units selected based on a multistage stratified random sampling	Date of publication of the annual landing statistics	All 9 maritime states and 2 Union Territoryies (Puduchery and Daman-Diu) marine fish landing data will be estimated

			method		
4	Rapid assessment of the status of exploited stocks, in maritime states and publication of policy briefs	The status of exploited stocks in the year is assessed systematically	The biological data on length-weight relationship and the landings data are used to assess the stock	Number of stocks exploited	Vulnerability status of the stocks will be published
5	Development of regional spatio-temporal resource mapping of distribution and abundance of fishes off Indian coast	The details of the distribution of fishery resources will be mapped	Resource maps comprising various components will be prepared	Number of fish species	Species wise distribution maps will be prepared
6	GIS based database for valuation of marine organisms such as coral and fish species	The data base on the marine flora and fauna will be developed and used for valuation of the ecosystem	The list of marine flora and fauna will be listed, identified and their use & non-use values will be estimated	Number of species	Valuation of the marine bio-diversity
7	Number of environmental impact parameters in hydrographic and benthic ecosystems	The status of coastal health will be assessed by estimating the indicators of pollution	The intensity of marine pollution, heavy metal concentration and extent of degradation of fragile habitats decides the coastal health	Number of parameters such as pollution index, degradation index	Pollution indices for environmental impact assessment
8	Number of surveys conducted to assess the health of ecosystem	Water sampling surveys will be conducted to assess the health of ecosystem	Data on various components of sea water will be collected	Number of surveys	Various components of water will be collected in the survey
9	Estimation of indicator/indices of socio-economic development and marketing efficiency in marine fisheries	The economic indicators like net income, profit/loss, productivity, net present value and payback period indicates the efficiency of the production &	The different fishing methods will be economically evaluated and the marketing efficiency will be estimated by developing	Number of indicators	The indicators will measure the strength of the socio economic status of the fishers, economic performance of fishing

		marketing system	suitable indicators		methods and also marketing efficiency.
10	Production of marine finfish seedlings	Broodstock for marine fin fish are developed by adopting different induced breeding methods. Various species of marine finfish will be farmed in open sea cages	The production of various species of marine fin fish and their seed will be assessed	Fish production in tonnes and seed in '000 numbers	Mariculture production figures
11	Process and product commercialization	Few products are developed as the output of some of the research activities. Such products after successful testing are taken for commercial-ization	The products or the process developed will be shared with the knowledge or working partner to expand the production on commercial scale	Number of products /processes commercializ ed	Bio-prospecting outputs
12	Consultancy services	The expertise in different fields of marine fisheries management and mariculture are utilized to help those clients who seek our help for solving their research problems in the concerned field	The consultancy services are taken up based on the requirement from the clients and worked on a project mode	Number of clients	Capture and culture related expertise provided to interested clients
13	Analytical and advisory service	Facilitating certain services like water testing, species identification	The services like water quality testing, disease & species identification are provided to farmers and students	Number of clients approached	Laboratory testing of samples
14	Number of trainees	Capacity building in fields of marine	Training is provided to fishers and fish	Number of trainees	Human resource development

		fisheries and mariculture is done through training of the fishers and fish farmers at regular intervals	farmers on various aspects of marine fisheries and mariculture		

Section 5: Specific performance requirements from other departments that are critical for delivering agreed results

Location Type	State	Organization Type	Organization Name	Relevant Success Indicator	What is your requirement from this organization?	Justification for this requirement	Please quantify your requirement from this organization	What happens if your requirement is not met?
Central Government	All India	Government Department	DAHD &F	Production of marine fin fish seedlings	Policy formulation and implementation support	This Department is the organization that promulgates policies after getting approval from the Government	Support to translate our research findings to policy measures	There will be a delay for the impact of the research of the institution in reaching the clients
Central Government	All India	Government Department	Space Applications Centre (SAC), Indian Space Research Organization	Development of grid-wise time series data base on chlorophyll abundance, marine catch, effort and catch rate with geo reference tags	Providing past years time-series data and current data on remote sensing and chlorophyll collected through their satellite	This is the only organization that collects data through remote sensing using the satellites sent in the orbit	Time series data for the last few decades and the current data on chlorophyll	The results will be delayed

Section 6: Outcome /Impact of activities of Department/Ministry

Sl. No.	Outcome/ Impact	Jointly responsible for influencing this outcome/impact with the following organization(s) /department(s) / ministry(ies)	Success indicator(s)	Unit	2012-2013	2013-2014*	2014-2015	2015-2016	2016-2017
1	Annual estimation of marine fish landings in India and socio economic indicators –State-wise	Department of Animal Husbandry, Dairying and Fisheries	Number of organizations using our data base	Number*	80	90	102	105	110
2	Productivity and production enhancement through mariculture-Open sea cage farming: Seed production	Ministry of Agriculture, National Fisheries Development Board	Number of farmers/organizations purchasing our seeds	Number	40	52	75	85	100
			Increase in productivity from the existing benchmark	Per cent	NA	NA	25[@]	30	35
3	Capacity building in stock assessment, taxonomy , open sea cage farming and hatchery technologies	Independently with funding from various agencies	Number of trainees	Number	588	375	650	800	840

Note: *We are retaining our original unit since it is the way in which our research efforts are measured

[@] Cage farming is in the initial phase of commercial farming by fish farmers and expected to pick up from this year with a few institutional and financial support from organizations like NFDB, DAHD &F and Banks.

TRAINING AND CAPACITY BUILDING

Programmes conducted

Subject	Place	Period
National biodiversity workshop	Karwar	21-22 May 2014
Marine ornamental fish breeding and aquarium management techniques	Mandapam	27 May - 06 June 2014
Kerala Marine Fisheries Regulation Act	Munambam	08-09 July 2014
Algal culture and identification of micro-algae	Kochi	22-26 July 2014
e-publication for newly constituted editorial committee members of the Indian Journal of Fisheries	Kochi	25-26 August 2014
Brainstorming session on oil sardine	Veraval	09-11 September 2014
Fish stock assessment and management	Kochi	15-27 September 2014
Modern approaches in aquaculture	Kochi	10-27 October 2014
Methods of valuation of ecosystem services	Chennai	03-07 November 2014
Mussel farming	Karwar	12-15 January 2015

Programmes undergone

Official	Subject	Organisation	Period
A. Udayakumar, Technical Officer	Water resources management	CWRDM, Neyyattinkara	11-13 June 2014
C.P. Suja, Senior Scientist Vidya Jayasankar, Senior Scientist Jayasree Loka, Senior Scientist	Agricultural research management for directly recruited senior/principal scientists	NAARM, Hyderabad	14-26 July 2014
Boby Ignatius, Principal Scientist	MDP on priority setting, monitoring and evaluation (PME) of agricultural research projects	NAARM, Hyderabad	04-08 August 2014
M.P. Paulton, Senior Technical Officer	Capacity building programme for technical officers	IIPA, New Delhi	08-19 September 2014
R. Saravanan, Scientist	Algae for sustainable agricultural production	ACRI, Madurai	29-30 September 2014

P. Laxmilatha, Principal Scientist	Certification and eco-labeling for sustainable fisheries	MSC, Kochi	10 November 2014
Jayasree Loka, Senior Scientist	Agricultural research management	NAARM, Hyderabad	10-22 November 2014
S. Sandhya Sukumaran, Scientist	Pre-conference NGS bioinformatics workshop	IoB, Bengaluru	15-16 November 2014
M.K. Anil, Principal Scientist	General management programme for scientists	ASCI, Hyderabad	17-28 November 2014
K.R. Sreenath, Scientist	Geo-statistics in ecological modeling	IIT, Kharagpur	24 November - 06 December 2014
A.K. Abdul Nazar, Senior Scientist	Emotional intelligence for personal and work excellence	NAARM, Hyderabad	25-28 November 2014
P.S. Swathilekshmi, Senior Scientist			
Karthireddy Syamala, Scientist	Gender mainstreaming and development	CIFE, Mumbai	12-23 December 2014
P.S. Asha, Principal Scientist	The science of living	AHE, Vadodara	05-09 January 2015

Rekha Devi Chakraborty, Senior Scientist	Molecular markers	NBFGR, Kochi
M. Anbarasu, Technical Assistant	Data analytics through statistical software	CIFE, Mumbai

Ph.D. Registrations granted

Cochin University of Science and Technology

V.S. Jayasree (DST INSPIRE Fellow); Guide: K.S. Sobhana
Wilson Sebastain (UGC Junior Research Fellow); Guide: Sandhya Sukumaran

Mangalore University

M. Anusree; Guide: Kajal Chakraborty
Fasina Makkar; Guide: Kajal Chakraborty
Shamal P; Guide: P.U.Zacharia
Dexy Joseph KC; Guide: Kajal Chakraborty

Ph.D. Theses submitted

Student	Guide	University
K.V. Akhilesh	N.G.K. Pillai	CUSAT
K. Vidya	Shoji Joseph	CUSAT
Anju Antony	P.C. Thomas	CUSAT
K.A. Sajeela	A. Gopalakrishnan	CUSAT
N.S. Jeena	A. Gopalakrishnan	CUSAT
C.P. Rajool Shanis	N.G.K. Pillai	CUSAT
N. Venugopalan	N.G.K. Pillai	Mangalore University
Suresh Kumar Mojada	Imelda Joseph	Mangalore University
N.K. Praveen	Kajal Chakraborty	Mangalore University
N.K. Sajesh Kumar	P.C. Thomas	Mangalore University

In the light of the workshop organized by the Council at the National Academy of Agricultural Research Management, Hyderabad, on 26 February 2015, a proposal has been prepared for the personnel of the scientific cadre and other staff to be trained during the remaining two years under the plan.

WOMEN'S CELL

Life without Diseases, talk organized by Women's Cell.

Women's Cell CMFRI organized a special lecture and an interactive session on "Life without Diseases" on 20th February 2015 by Dr. Jacob Vadakkanchery, Nature Life International, Ernakulum. Dr. V. Kripa, Principal Scientist & Head, FEM Division, presided over the function. The programme highlighted the benefits of natural way of life to lead a life without diseases and the discussion resulted in valuable guidance towards healthy life.

International Women's Day

Under the auspices of Women's Cell, the International Women's Day was observed on 10th March, 2015 at CMFRI, Kochi. Dr. M. Lekshmikumari, Chairperson, Vivekananda Kendra Vedic Vision Foundation, Kodungallore was the Chief Guest. She delivered a talk on "Holistic Approach to Human Life". Through her enchanting, spiritual, but not religious, thought filling address, Dr. Lekshmikumari had taken the CMFRI audience into a trance. The talk was very rejuvenating and positive to all those who attended it. Dr. V. Kripa, Principal Scientist presided over the function.

RESEARCH MANAGEMENT AND STAFF WELFARE

Research Advisory Committee (RAC) meeting

The 19th RAC meeting of CMFRI was held at CMFRI, Headquarters (HQ), Cochin from 26-27 March 2015. The following members of the RAC attended the meeting:

1.	Dr. B.N. Desai, Ex-Director National Institute of Oceanography	Chairman
2.	Dr. Madan Mohan, ADG (Marine. Fisheries), ICAR	Member
3.	Dr. R.A. Selvakumar, Former ADG (Marine Fisheries) ICAR	Member
4.	Dr. C.B.S. Dutt, National Remote Sensing Centre (NRSC), Hyderabad	Member
5.	Dr. E. Vivekanandan, Principal Scientist (Retd.), CMFRI	Member
6.	Dr. A. Gopalakrishnan, Director CMFRI	Member
7.	Dr. P.U. Zacharia, Head, DFD, CMFRI	Member Secretary

Dr. B.N. Desai, Chairman, RAC made the introductory remarks. He observed that most of the RAC recommendations given last year have been implemented by the Institute.

Dr. A. Gopalakrishnan, Director CMFRI, presented the highlights of research activities for the year 2014-15. The Action Taken Report (ATR) on the recommendations of the 18th RAC was presented by Dr. Zacharia, Head, Demersal Fisheries Division and Member Secretary followed by discussions.

All Heads of Divisions and SICs of Regional/Research centers made

presentations on the progress of work with reference to their Divisions/ Centres for the year 2014-15. The activities of KVK were presented by the Programme Coordinator. After each presentation, there were discussions and critical evaluation by members of RAC. Following are the major recommendations submitted to the Council.

1. One prioritized activity for each Research/Regional Centre should be finalized during the forthcoming IRC and should be incorporated as a technical program in on-going In-house projects.

2. CMFRI should consider collaboration/support from ISRO/NRSA to undertake satellite tracking of fishing vessels as a means of effective fisheries management related activity and to reap benefits of newly launched satellites.

3. Socio-Economics Evaluation & Technology Transfer Division to have collaboration with Indian Institute of Management (IIM), Institute of Social Economics (IISE), Bangalore and Tata Institute of Social Sciences (TISS), Mumbai to get a different perception of the problems faced by the fisheries sector.

4. Annual commercial production statistics from cage aquaculture and bivalve farming to be included in marine production statistics. Similarly, the marine fish landings of Lakshadweep & Andaman and Nicobar group of Islands may also be incorporated in the estimated marine fish landings of CMFRI.

Institute Research Council (IRC)

The 21st IRC Meeting was held at CMFRI HQ, from June 24th – 28th 2014. The progress of the research work in the Divisions, both in-house (32) and externally funded (31) and various sections during the period 2013-14 were presented by the respective Heads of Divisions, Principal Investigators and Scientists/Officers-in-charge of the concerned sections. The presentations were followed by critical evaluation and discussions. All Scientists of CMFRI attended the IRC Meeting.

76th Meeting of the Institute Management Committee (IMC) of CMFRI

The 76th Meeting of the Institute Management Committee (IMC) of CMFRI was held on 21.10.2014 at CMFRI, HQ. Review of the action taken on the items considered during the previous meeting held on 25.02.2014 at CMFRI was done. The IMC nominated Dr. (Smt.) V. Kripa, Principal Scientist & Head, FEM Division, Shri Rakesh Kumar, Chief Administrative Officer and Shri A.V. Joseph, Chief Finance and Accounts Officer as Members to the Institute Grievance Committee. Expenditure amount allotted under Plan and Non–Plan 'Works' for the Financial Year 2014-15 was reviewed. The IMC approved for the procurement of 74 nos. of equipment during the financial year 2014-15. The IMC also reviewed the Internal Audit Summary report of the ISO Certification process.

77th Meeting of the IMC CMFRI

The 77th Meeting of the Institute Management Committee of CMFRI was held on 06.05.2015 at CMFRI, HQ. Review of the action taken on the items considered during the previous meeting held on 21.10.2014 at CMFRI was done. The IMC approved the Consultancy Projects costing more than Rs. 50 lakhs which were active/ initiated during the period 2015-16. The IMC conveyed post-facto approval/sanction for the new works taken up during

2014-15. The IMC recommended the proposal for getting approval and expenditure sanction of the Council for out sourcing of security contract of CMFRI HQ and Regional/Research Centres during 2015-16. The IMC approved/ recommended the prioritized items of new works to be undertaken under Plan and Non–Plan during the year 2015-16. The IMC approved procurement of Gel Documentation System and PCR with electrophoresis apparatus and High Speed Centrifuge against the approved EFC documents. The IMC approved for the procurement of equipments for the ICAR outreach activity at CMFRI, Kochi.

Institute Joint Staff Council (IJSC)

Fifth meeting of the XII IJSC was held at CMFRI Headquarters on 09-05-2015. Sixth meeting of the XII IJSC was held at Calicut Research Centre on 01-10-2-14and seventh meeting was held at CMFRI HQ on 13-02-2015.

MAJOR EVENTS 2014-15

Hon'ble Agriculture Minister Shri Radha Mohan Singh at CMFRI

Certificate presented by Dr. David Agnew, Director of Standards, Marine Stewardship Council (MSC), London

ADG Marine Fisheries Dr. Madan Mohan at Uppunda, Mangalore

Dr.Trevor Platt joins CMFRI

ICAR sponsored MarineBiodiversity Summer School

Fish landing data of the year 2013 released on 2 June 2014

Vijayan KK sent off as Directror CIBA from CMFRI

ICAR Foundation Day 29. July 2014 CMFRI Memento to PM by AM

DDG Fisheries Dr. Meenakumari at 10IFAF Stall

Launch of Research vessel RV Cadalmin 1

ICAR Foundation Day 29 July 2014 CMFRI Memento to MoS Dr. Sajeev Kumar Balyan

Director visits Veraval Regioanl Centre flanked by Sidi tribals

New Year celebration 2105

DISTINGUISHED VISITORS

CMFRI HQ, Kochi

Shri Radha Mohan Singh, Hon'ble Union Agriculture Minister

Dr. B. Meenakumari, Deputy Director General (Fy.), ICAR, New Delhi

Dr. Rashid Sumaila, Professor of Fisheries Economics and Director, University of British Columbia, Canada

Dr. Ned Cyr, Director, National Marine Fisheries Service NOAA, USA

Dr. Usha Varanasi, Former Director, Northwest Fisheries Science Center (NWFSC), NOAA, USA

Dr. David Agnew, Director of Standards, Marine Stewardship Council (MSC), London

Dr. Hem Pandey, Additional Secretary, Ministry of Environment and Forests (MoEF), New Delhi

Mr. Ravi Singh, CEO and Secretary General, World Wildlife Fund (WWF) India, New Delhi

Dr. Andy Cornish, World Wildlife Fund (WWF)

Dr. Leena Nair, Chairperson, MPEDA, Kochi

Dr. S.W.A. Naqvi, Director, National Institute of Oceanography, Goa

Shri K. Babu, Minister for Fisheries, Ports and Excise, Govt. of Kerala

Shri K.P. Mohanan, Minister for Agriculture, Govt. of Kerala

Dr. P. Ranjendran, Vice-Chancellor, Kerala Agriculture University, Thrissur

Dr. B. Madhusoodana Kurup, Kerala University of Fisheries and Ocean Studies, Kochi

Dr. B. Ashok, IAS, Kerala Veterinary and Animal Sciences University, Pookode, Waynad

Dr. K.M.L. Pathak, Deputy Director General (AS), ICAR, New Delhi

Dr. S.M. Shivaprakash, Director of Extension, Karnataka Veterinary and Fisheries Science University, Bidar, Karnataka.

Dr. Pawan Kumar, Indian Agricultural Statistics Research Institute, New Delhi

Dr. N. Anilkumar, Director (Biodiversity), M S Swaminathan Research Foundation

Dr. Y.S. Yadava, Director, Bay of Bengal Programme, Chennai

Dr. Manjit Singh, Director, Directorate of Mushroom Research, Himachal Pradesh

Dr. T.H. Gowda, Director of Extension, UAHS, Shimoga

Mr. Inio B. Seruiratu, Minister of Agriculture, Rural & Maritime Development and National Disaster Management, Republic of Fiji

Dr. J. K. Jena, Directror, National Bureau of Fish Genetic Resources, Lucknow

Dr. A.G. Ponniah, Former Director, CIBA, Chennai

Dr. E.G. Silas, Former Vice-Chancellor, KAU, Trivandrum

Dr. P.S.B.R. James, Former Director, CMFRI, Kochi

Dr. V.S.R. Murthy, Former Principal Scientist and HOD, CMFRI, Kochi

Dr. Rudolf Hermes, BOBLME, Phuket, Thailand

Dr. S.S. Kohli, DST, New Delhi

Dr. Chowdappa, Director, CPCRI Kasaragod

Dr. T.K. Srinivasa Gopal, Former Director, CIFT, Kochi

Dr. C.N. Ravishankar, Director, CIFT, Kochi

Dr. Arun S. Ninawe, Scientist G and Sr. Advisor (Aquaculture and Marine Biotechnology), DBT, New Delhi

Mumbai Research Centre

Dr. S. Ayyappan, Secretary, DARE & Director General, ICAR, New Delhi

Dr. Ranjan Samantry, GEF-NAIP-ICAR, World Bank Review Mission

Ms. Sharlin, World Bank, GEF-NAIP-ICAR, World Bank Review Mission

Ms. Indu Murti, World Bank, GEF-NAIP-ICAR, World Bank Review Mission

Dr. A. N. Singh, Managing Director, Celestial Biolabs Ltd, Hyderabad

Mr. Augusto Antonio Generoso First Secretary, High Commission of the Republic of Mozambique

D**r. L. Kannan,** Chairman, Advisory committee, National Fund Project, NFBSFRA and former Vice-Chancellor, Thiruvalluvar University, Vellore, Tamil Nadu

Shri R. R. Patra, Vice President, JSW Infrastructure Ltd., Mumbai

Ms. Monica Chavan Manager Environment, JSW Infrastructure Ltd., Mumbai

Dr. P.S.B.R James, Former Director, CMFRI, Kochi

Dr. Arun K Pandey, Director, ITRA-Water, Ministry of IT, Govt. of India

Prof (Dr.) Ravindra Nath, Indian Institute of Science, Bangalore

Dr. Harshaman, Dr. Tang, Dr. De Silva and Dr. Ganguli, Compliance Review Panel, ADB

Dr. B. N. Desai, Former Director, National Institute of Oceanography, Goa

Dr. Dipankar Saha, Shri Arijit Muzumdar and **Shri T.K. Basak**, Creative Research Group, Kolkata

Shri Chandra Shekhar, Secretary (SS), **Shri Devendra Kumar** and **Shri. Mahesh Waghela,** Committee Members, Central Joint Staff Council of ICAR, New Delhi

Karwar Research Centre

Shri Amjad Tak, IAS, Secretary (Fisheries), Govt.. of Goa

Dr. Shamila Monteiro, Director, Directorate of Fisheries, Goa

Vizhinjam Research Centre

Dr. B. Meenakumari, Deputy Director General (Fy.), ICAR, New Delhi

Dr. T.K. Srinivasa Gopal, Former Director, CIFT, Kochi

Tuticorn Research Centre

Dr. J. K. Jena, Director, Na tional Bureau of Fish Genetic Resources, Lucknow

Dr. Arun S. Ninawe, Scientist G & Sr. Advisor (Aquaculture and Marine Biotechnology), DBT, New Delhi

Smt. S. Mathumathi, IAS, Commissioner, Tuticorin Municipal Corporation

Shri Amal Xavier, Joint Director of Fisheries, Govt. of Tamil Nadu

Dr. G. Sugumar, Dean-in-Charge, Fisheries College & Research Institute, Tuticorin

Shri V.S. Malick, IFS, Chief Conservator of Forests (Forest Protection Squad- South Zone), Chennai

Shri Andiappan, Asst. Conservator of Forests, Tirunelveli, Tamil Nadu

Mandapam Regional Centre

Shri K. Nanthakumar IAS, District Collector, Ramanathapuram, Tamil Nadu

Madras Research Centre

Dr. Faiza Yousif Al Yamani, Executive Director of the Environment and Life Sciences Research Centre, Kuwait Institute for Scientific Research, Kuwait

Visakhapatnam Regional Centre

Dr. Madan Mohan, ADG (M. Fy.), ICAR, New Delhi

Dr. C. N. Ravishankar, Director, CIFT, Kochi

Mr. Tewolde Woldemikael, Director General, Marine Resource Development Department, Ministry of Marine Resources, Massawa, Eritrea

MARINE BIODIVERSITY MUSEUM

The Designated National Repository Museum of CMFRI, recognized by the Government of India is authorized to keep in safe custody specimens of different categories of biological material. Currently the museum houses 2034 specimens belonging to different groups of marine organisms.

New additions to the Museum during 2014:

Total specimens: 76
New species: 1

Fishes

1. *Acanthurus bariene* Lesson, 1831
2. *Carcharhinus falciformis* (Muller & Henle, 1839)
3. *Crossorhombus azureus* (Alcock, 1889)
4. *Loxodon macrorhinus* Muller & Henle, 1839
5. *Macolor macularis* Fowler, 1931
6. *Mola ramsayi* (Giglioli, 1883)
7. *Plectranthias alcocki* Bineesh, Akhilesh, Gopalakrishnan & Jena, 2014
8. *Proscyllium magnificum* Last & Vongpanich, 2004
9. *Roa jayakari* (Norman, 1939)
10. *Stegastes fasciolatus* (Ogilby, 1889)
11. *Tripterodon orbis* Playfair, 1867
12. *Wallago attu* (Bloch & Schneider, 1801)

Molluscs

1. *Anadara antiquata* (Linnaeus,1758)
2. *Acar plicata* (Dillwyn, 1817)
3. *Anadara broughtonii* (Schrenck, 1867)
4. *Anadara multicostata* (G. B. Sowerby I,1833)
5. *Anadara pumila* (Dunker, 1868)
6. *Anadara transversa* (Say, 1822)
7. *Anadara trapezia* (Deshayes,

1839)
8. *Anomia cytaeum* Gray, 1850
9. *Anomia ephippium* Linnaeus ,1758
10. *Anomia simplex* d'Orbigny, 1853
11. *Asperarca nodulosa* (O.F. Muller, 1776)
12. *Atrina vexillum* (Born, 1778)
13. *Barbatia amygdalumtostum* (Roding, 1798)
14. *Barbatia barbata* (Linnaeus, 1758)
15. *Barbatia candida* (Helbling, 1779)
16. *Barbatia foliata* (Forsskal in Niebuhr, 1775)
17. *Barbatia obliquata* (Wood, 1828)
18. *Conomurex decorus* (Röding, 1798)
19. *Conus kintoki* Habe & Kosuge, 1970
20. *Crassostrea belcheri* (G. B. Sowerby II, 1871)
21. *Crassostrea bilineata* (Roding, 1798)
22. *Crassostrea gigas* (Thunberg, 1793)
23. *Crassostrea gryphoides* Linnaeus, 1758
24. *Cucullaea labiata* (Lightfoot, 1786)
25. *Cucullaea petita* Iredale, 1939
26. *Decatopecten plica* (Linnaeus, 1758)
27. *Dendostrea frons* (Linnaeus ,1758)
28. *Drupa morum* Röding, 1798
29. *Drupina lobata* (Blainville, 1832)
30. *Hawaiarca weberi* (Prashad, 1932)
31. *Hyotissa hyotis* (Linnaeus, 1758)
32. *Hyotissa inermis* (G.B. Sowerby II, 1871)
33. *Linckia laevigata* (Linnaeus, 1758)
34. *Littoraria scabra* (Linnaeus, 1758)
35. *Lopha cristagalli* (Linnaeus, 1758)
36. *Mauritia depressa* (J. E. Gray, 1824)
37. *Mauritia eglantina* (Duclos, 1833)
38. *Mesocibota bistrigata* (Dunker, 1866)
39. *Mimachlamys varia* (Linnaeus, 1758)
40. *Oxymeris felina* (Dilwyn ,1817)
41. *Palmadusta lentiginosa* (J. E. Gray, 1825)
42. *Pinna atropurpurea* G. B. Sowerby I, 1825
43. *Saccostrea echinata* (Quoy & Gaimard, 1835)
44. *Saccostrea glomerata* (Gould, 1850)
45. *Saccostrea scyphophilla* (Peron & Lesueur, 1807)
46. *Septa rubecula* (Linnaeus, 1758)
47. *Spondylus limbatus* G. B. Sowerby II, 1847
48. *Tegillarca aequilatera* (Dunker, 1868)
49. *Tegillarca granosa* (Linnaeus, 1758)
50. *Tegillarca nodifera* (Martens, 1860)
51. *Tellina linguafelis* Linnaeus, 1758
52. *Tellina palatum* Iredale, 1929
53. *Tenguella granulata* (Duclos, 1832)
54. *Thalessa virgata* (Dillwyn, 1817)
55. *Trisidos tortuosa* (Linnaeus, 1758)
56. *Trochus erithreus* Brocchi, 1821
57. *Vasum tubiferum* (Anton, 1838)
58. *Volegalea carnaria* (Röding, 1798) + operculum
59. *Vulsella vulsella* (Linnaeus, 1758)

Crustaceans

1. *Oplophorus gracilirostris* A. Milne-Edwards, 1881
2. *Plesionika quasigrandis* Chace, 1985

Visitors during January to December 2014

Month	No.of Schools	Students	No.of Colleges	Students	Public	Total	Revenue generated (₹)
January	7	810	12	391	97	1298	13950
February	23	1379	20	637	111	2127	22380
March	4	211	10	403	74	688	7620
April	1	210	3	72	96	378	4748
May	1	63	8	331	176	570	7460
June	0	0	3	75	70	145	2150
July	0	0	1	20	124	144	2680
August	1	59	3	70	42	171	2130
September	2	320	8	316	68	704	7720
October	9	453	3	61	41	555	5960
November	5	385	6	158	74	617	6910
December	8	550	5	124	168	842	10100
Total	61	4440	82	2658	1141	8239	93808

Isopod

1. *Norileca indica* (H. Milne Edwards, 1840)

Sea Birds

1. *Anous stolidus* (Linnaeus, 1758)
2. *Sula dactylatra* Lesson, 1831

Visitors to the Marine Biodiversity Museum, CMFRI, Cochin during 2014

- A total of 8239 persons from 21 States and 4 Union Territories of the country visited the Marine Biodiversity Museum, CMFRI, Cochin during 2014
- Students from 61 Schools and 82 colleges visited the Museum
- 16 International delegates representing Bangladesh, Bhutan, France, Indonesia, Maldives, Myanmar, Netherlands, Rome and Sri Lanka visited the Marine Biodiversity Museum,

KRISHI VIGYAN KENDRA

Frontline demonstrations (FLDs)

- **Integrated crop management (ICM):** ICM in paddy increased yield by 25%. ICM included application of lime, neem cake, *Azospirillum*, panchagavya, fish amino acid, *Trichoderma* enriched vermicompost, *Beauveria verticilium* and neem oil spray. Seeds were treated with *Pseudomonas* and regular application was done as foliar spray. Trichocards were also installed.

- **Integrated pest, disease and nutrient management (IPDNM) of coconut palms:** helped to rejuvenate senile coconut palms. IPDNM for coconut includes crown cleaning, application of recommended dosage of chemical fertilizers in two splits, lime application, application of *Trichoderma* enriched cow dung, neem cake, bordeaux mixture and *Pseudomonas*. The cost per plant per year is ₹500.

- **Integrated pest, disease and nutrient management (IPDNM) of nutmeg:** helped to prevent fruit drop and fruit decay. It increased fruit set by 12% and decreased fruit drop and fruit decay by 18-25%. Immature nut fall and leaf shedding decreased considerably. The IPDNM comprises application of *Trichoderma* enriched cow dung, neem cake, potash, bordeaux mixture and *kocide* spray.

Open precision farming: Open precision farming of bittergourd increased yield by 85%. Fertigation through ventury system and plastic mulching were

Precision farming of bittergourd

the essential components of precision farming. This arrangement in addition to saving nutrient loss also reduced labour required for weed management. "Pheromone traps" were used for pest control against fruit fly and "yellow sticky traps" were used against whiteflies. Apart from this, neem oil spray was also done as an organic pest repellent.

- **Alternate spray of *Beuveria bassiana* and *Pseudomonas*:** controlled pest and disease in cucurbit crops.
- **Liming increased crop yield:** liming at the rate of 3.5 kg per one cent increased yield of tapioca by 18%
- **Medicinal paddy variety *Njavara*:** profitably cultivated in Ernakulam District. This variety has good medicinal properties and the yield obtained was 3.5 mt ha^{-1}.
- **Monoculture of indigenous fish *Varal* (*Channa* sp.):** resulted in high rate of cannibalism and low survival percentage. A unique species specific feed for varal is required to carry out its monoculture.
- **High density cage culture in granite quarries:** is a perfect method for utilising granite quarries for fish production. Tilapia, *Pangasius* and pearlspot were found suitable candidate species.
- **Integration of high value finfish, shrimp and paddy in pokkali fields:** Integrated farming of finfish such as pearlspot, mullet and Asian seabass along with shrimp and paddy in pokkali fields was found to ensure high remuneration per unit area.
- **Breeding and seed production of pearlspot in ponds:** was found to be a profitable venture. Small sized ponds (50 to 1 acre) are ideal for community breeding of pearlspots. Seed collection can commence from 75 days of stocking the brood fish.
- **Onion variety *Agrifound dark red*:** found suitable for growing in riverine alluvial soils and sandy loam area of Ernakulam District.
- **Spray of sulphate of potash (SOP) in Nendran banana bunches:** increased yield (bunch weight) by 15-20% .

Findings of on-farm testing (OFT) programmes

- Fruit rot disease in nutmeg can be controlled by applying 40 kg cow dung enriched with 4 kg neem cake and 500 g *Trichoderma* applied in 2 split doses per plant per year in combination with 20 g *Pseudomonas* diluted in 1 litre, sprayed over the canopy at monthly intervals.
- Mini tillers are suitable for ploughing in pokkali paddy fields when dried to an extent that a person can walk over the field. Pokkali fields can be dried by pumping water out. The field capacity of mini tiller is 1.5 acre per day.
- Application of *Verticilium leccanii*, 20 g diluted in 1 litre of water in 4 doses can ensure cent per cent control of banana rhizome mealy bugs. First application is to be done at the end of 3rd month of planting with subsequent applications at monthly intervals.

- Application of *Azospirillum* mixed with neem cake and farm yard manure (FYM) in 1:2:20 ratio at 3rd, 60th and 120th days of planting of banana can reduce usage of chemical fertilizers by 25%, which can help to reduce production cost.

- Yield of the fodder variety, Thumburmuzhi TM-1(170 metric t ha^{-1}) was found to be less than hybrid napier variety CO3 (245 metric t ha^{-1}). However TM-1 was found to be more suitable for feeding small animals like goats and rabbits.

- Yield of vegetables grown in flat planting beds and grow bags were found comparable and cost involved is on the lower side for grow bags.

Entrepreneurship development programmes (EDP)

- **Climate resilient aquaculture:** EDP on 'Climate resilient aquaculture' was organised at CMFRI, Kochi during 6th - 10th March 2015. Fifteen selected youth attended this programme funded by National Initiative on Climate Resilient Agriculture (NICRA). Interaction with fisheries scientists, successful farmers and entrepreneurs were the highlights of the programme. KVK extends technology backstopping to these candidates for initiating enterprises in aquaculture. KVK also provides assistance to the trainees in project report preparation for availing loans and also in establishing assured market linkages.

- **Tapioca processing:** EDP on tapioca processing was organised at Vengola, Ernakulam on 5th November 2014. More than 100 candidates including farmers, Kudumbashree SHG members and officials participated. Dr. M.S. Sajeev, Principal Scientist, ICAR-Central Tuber Crops Research Institute (CTCRI), Thiruvananthapuram served as subject expert, who introduced scope of preparing a spectrum of products from cassava including noodles, pasta, variety of snack foods and starch. Budget of ₹5.00 lakhs was estimated for setting up of small scale industry for processing tapioca. An exhibition of cassava products was also arranged.

Dr. M.S. Sajeev Principal Scientist, CTCRI, Thiruvananthapuram taking class during EDP on tapioca processing

- **Meliponiculture:** EDP on meliponiculture was initiated to attract enterprising youth to agriculture. The programme was launched at Kothamangalam on 24th October 2014 and again followed up on 24th January 2015 by extending a preliminary training to more than 100 candidates. Capacity building on honey processing, obtaining small food safety licenses, packing, test marketing and establishing marketing channels formed part of the programme. KVK supplied stingless bee hives and colonies at reasonable price to the participating entrepreneurs. Stingless honey costs around `1500 to 2000 per kg. Centralised marketing of quality split hives is also envisaged under the programme.

Other Programmes

Demonstration of farmgate markets in pokkali fields

Farm gate markets for live caught pearlspot (*Etroplus suratensis*) and mullet (*Mugil cephalus*) grown organically in pokkali fields was demonstrated at Kappu padasekharam near Nayarambalam and Anjilithara padasekharam near Kumbhalangi on 19th April 2014. The field markets attracted hundreds of fish lovers from Kochi and nearby districts making the concept promising. The programme was conducted as part of the National Initiative on Climate Resilient Agriculture (NICRA), with the objective to popularise superior quality and taste of the fish harvested from pokkali fields. The paddy straw of the previous crop, the peaty soil and the saline water in the pokkali eco-system together imparts a characteristic taste to the fish from pokkali fields.

Shri. S. Sarma, MLA inaugurating the farmgate market at Kappu pokkali fields, Nayarambalam

Branding and marketing of pokkali produce

With the objective of enhancing the income from unit area for pokkali farmers and ensuring availability of nutritionally rich natural organic pokkali produce to the consumers, technology demonstration was conducted at selected fields of 7 farmer partners located at Kadamakkudy, Pizhala and Nayarambalam, under NICRA project. Pokkali rice, and its value added products, pearlspot (k*arimeen*), mullet (*thirutha*), shrimp (*chemmeen*) marketed for a premium

price in a common brand would ensure more remuneration for the pokkali farmers, thereby ensuring sustainability of this traditional and world renowned farming system of Kerala. The brand name for the pokkali produce will ensure safe-to eat products for the consumers at a reasonable price while enhancing the income from pokkali farming towards its sustainability.

Self employment in freshwater fish farming with KVK's technology backstopping

Samanwaya men SHG from Paliyamthuruthu, Paniyely, Ernakulam District, successfully conducted freshwater fish farming near Paniyely under the technical guidance of KVK. The group participated in the Entrepreneurship development programme (EDP) of KVK in June 2013 and subsequently initiated fish farming in a 1 acre abandoned granite quarry. Indian major carps, grass carp and *Pangasius* fingerlings (4000 nos.) were stocked in July 2013. Systematic and scientific farming right from pond preparation through feeding and disease management resulted in size ranges from 0.6 to 3.9 kg during a short period of 9 months. Harvest festival was organised on 17th April 2014 and freshly caught live fish were sold locally @175 per kg.

KVK - Kudumbashree joint initiative to create women forces for agro-mechanisation

Labour shortage is one of the main reasons preventing growth of agriculture sector in Kerala. Popularising mechanisation and developing skilled labour force to operate and maintain agro-machinery is the only alternative. KVK initiated a programme in collaboration with District Kudumbashree Mission with financial assistance from Mahila Kisan Sasaktikaran Pariyojana towards developing women task forces among Kudumbashree members for agro-mechanisation. A series of field trainings of 3 days duration was organised for selected Kudumbashree members from all blocks in the district wherein 150 women got trained. Intensive training was given on operation and maintenance of mini tiller, weed cutter, earth auger, motorised sprayers, motorised duster and manually operated sprayers. The programmes were held in 15 blocks of the district during August-October 2014.

Capacity building of women groups towards mechanised farming in Ernakulam District

Popularisation of *kadaknath* poultry in Ernakulam District

KVK collaborated with Central Poultry Development Organization (CPDO), Mumbai for popularising Kadaknath breed poultry in Ernakulam District. Kadaknath is an indigenous breed from Madhya Pradesh known for medicinal properties of its meat and egg. Pure bred hatching eggs would be supplied by CPDO to KVK which would be hatched out and supplied to the farmers at nominal price after ensuring vaccination and other precautions. This arrangement would ensure supply of pure bred and quality birds in the district.

Harvest mela of short duration tapioca variety *Vellayani hraswa*

The short duration tapioca variety *Vallayani harswa*, developed by Kerala Agricultural University was demonstrated in the fields of 10 selected farmers of Vengola and Mooknoor Panchayats. This variety matures in 5-6 months whereas other varieties popular in the district require 10-12 months. *Vellayani hraswa* has got good cooking quality and marketability. In order to popularise the variety, KVK conducted a harvest mela on 3rd June 2014 at Vengola. The demonstration yielded on an average 7.2 mt ha^{-1}.

Shri. Saju Paul, MLA inaugurating *Vellayani hraswa* harvest mela at Vengola on 3rd June 2014

Satellite production centre (SPC) for pearlspot seeds

In order to meet the ever increasing demand of pearlspot seeds, KVK commenced a Satellite Production Centre (SPC) in the farm of Shri. Shibu Kochery near Kumbalanghi, Ernakulam District. KVK supplied quality broodstock and the farmer was trained on scientific seed production technology. Technology backstopping was extended from KVK. This SPC

supply fingerlings acclimatised to both freshwater and brackishwater. First sale from this SPC was held on 19th January 2015. The SPC has a production capacity of 35000 nos. of seeds per annum.

Shri. Saju Paul, MLA inaugurating *Vellayani hraswa* harvest mela at Vengola on 3rd June 2014

Vegetable task force

KVK has formed a task force for promoting kitchen gardens and organic vegetable production in urban homes. Vegetables planted in grow bags, a 100 days chart indicating crop care and management along with quality organic inputs are supplied by the group. Technology backstopping is provided from KVK.

Capacity building of differently abled youth on vegetable seedling production

As part of Farmers Field School programme, KVK conducted series of capacity building programmes on 'Scientific vegetable seedling production' exclusively for differently abled youth near Palluruthy, Ernakulam District. KVK scientists demonstrated and trained the participants on seedling raising. The polyhouse sanctioned from State Horticulture Mission was utilised for the programme. Nearly 25,000 nos. of seedlings of tomato, brinjal, chilli, capsicum, cabbage, cauliflower, okra and cowpea were produced by the trainees, which were later sold through sales melas organised at CMFRI, Kochi during 26th to 28th November and 15th December 2014.

Demonstration of KVK products in farmer's fields

As part of the Crop Health Management project funded by the Department of Agriculture, Government of Kerala, KVK conducted 20 farmer's field demonstrations of the products from KVK Ernakulam *viz.*, panchagavya, pheromone traps, fruit fly bait traps, Neem de pest at Edakkattuvayal and Pampakkuda near Ernakulam. Panchagavya spray in bittergourd and snake gourd at 20, 30 and 40 days after planting initiated more female flowering (10-15%) than control. Prophylactic sprays of Neem de pest were effective in preventing whiteflies, aphids and leaf minors. Pheromone traps and bait traps were found effective in controlling fruit flies. The infection level reduced

to 7-10% from 20-25%.

Programmes to attract youth to agriculture

- One day training on 'Aquaculture practices and prospects' was organised for students from Govt. Fisheries Vocational higher Secondary School (VHS), Kaipamangalam, Thrissur on 24th September 2014. Hands-on training on small scale cage fabrication as well as erection and nursery rearing of mullets were provided for the students.

- One day training on 'Aquaculture practices and prospects' for students from Government Fisheries Vocational Higher Secondary School, Narakkal and Government Regional Fisheries Vocational Higher Secondary School, Thevara on 21st October 2014. Students were trained on various vocational projects in aquaculture and location specific technologies like cage culture, scientific mullet farming and pearl spot seed production

- Six days on-job vocational training was conducted for students of Government Fisheries Vocational Higher Secondary School, Narakkal on 'Demonstration of value added products from fish, prawn and clam' during 18th to 24th October 2014. In addition to sessions on preparation of different types of fish pickles, fish wafer, fish fingers, fish cutlets, fish balls, dried prawn roast and chutney powder; classes on packing, labelling, branding and test marketing of the products were also included in the curriculum.

Review workshop of KVKs

The annual zonal review workshop of KVKs of zone VIII comprising of Tamil Nadu, Karnataka, Kerala, Goa, Lakshadweep and Puducherry was held at

Shri.T. K. Jose IAS inaugurating Annual zonal review workshop of KVKs

CMFRI, Kochi during 5th to 8th May 2014. Workshop reviewed the progress of work of 81 KVKs of the zone for the year 2013-14. The review was conducted by an expert team comprising of scientists from Zonal Project Directorate, Bengaluru and various ICAR institutes.

Scientific Advisory Committee meeting of KVK

The Scientific Advisory Committee (SAC) meeting of KVK for the year 2014-15 was held at CMFRI, Kochi on 10th February 2015. It was decided during the meeting that KVK may start Kisan Mobile Advisory service to spread recent technologies among farmers. It was also decided to initiate mobile sales counter for KVK products, soil testing facility at CMFRI and to expand the existing sales counter.

Scientific Advisory Committee (SAC) meeting of KVK

Field training centres of KVK

- **Mushroom cultivation:** A field mushroom training centre was set up by KVK at Koovappady near Perumbavoor in Ernakulam District. Mr. A.R Sreekumar, a successful trainee of KVK who is into mushroom farming

KVK's farmer trainer Shri. A.R. Sreekumar in the field training centre for Mushroom cultivation

demonstrates the process of mushroom farming to the trainees. The centre which produces mushroom round the year is also equipped with spawn production facility.

- **Rain shelter farming:** KVK's field training centre for rainshelter farming commenced in the field of Shri. Shabi Mohan near Elamakkara, Kochi. The centre is equipped with a 40 m^2 rainshelter, and vegetables are grown in bags. The unit is also equipped with timer controlled fertigation system. It is envisaged to train urban dwellers on round the year production of vegetables for home consumption.

Success story

KVK's satellite carp seed production unit augmented income of partner farmer

KVK commenced a satellite carp fish seed production unit, using portable carp hatchery (PCH) developed by Central Institue of Freshwater Aquaculture

Mr. Joseph Thakadiyil supplying carp seeds from the satellite carp seed production unit of KVK

(CIFA) at the farm of Mr. Joseph Thakadiyil in Kothamangalam. *Catla catla, Labeo rohita* and *Cyprinus carpio* were bred in the portable carp hatchery system. Fish seed produced are reared for two months in nursery ponds till marketable size using formulated and farm made low cost feeds and then sold to farmers. Mr. Joseph is now earning ₹1.5 lakhs per year from the carp seed production unit.

Products

Pearlspot feed *Pearlplus*

Exclusive feed for pearlspot under the trade name Pearlplus was launched by KVK. The feed was developed by Central Marine Fisheries Research Institute, Kochi. The launching was done as part of National Initiative on Climate Resilient Agriculture (NICRA) project. The feed contains 47% protein, 6% fat

Pearlspot feed *Pearlplus*

and also other essential nutrients such as vitamins and minerals. *Pearlplus* is available in five different sizes PS1 (250 µm), PS2 (500 µm), PS3 (1000 µm), PS4 (1.4 mm) and PS5 (2 mm). PS1 and PS2 are ideal for feeding pearlspot fry of 1 to 2.5 cm size while PS3 and PS4 are suitable for fingerlings of size 2.5 to 8 cm. PS5 is ideal for feeding fingerlings above 10 cm size. *Pearlplus* is available for sale in 1 kg and 5 kg packets at CMFRI-ATIC/KVK sales counter.

Micronutrient mixture for vegetables (*Vegetable topup*)

KVK supplied vegetable micronutrient mixture (*Vegetable topup*) to Department of Agriculture, Government of Kerala in all the districts of Kerala for the consecutive 2nd year to conduct micronutrient demonstrations as part of their vegetable development programme. The micronutrient mixture, as per the previous year's reports from the different districts, was found to have a definite positive impact on yield. An increase in yield of about 15-20% was reported from different districts.

ATMA-KVK Linkage

- Participated in the Technology Meet organised by Agricultural Technology Management Agency (ATMA), Ernakulam at Mahathma Gandhi Town hall, Aluva during 28th - 29th October 2014. KVK Subject matter specialist handled class on 'Recent advances in banana cultivation' to the farmers during the meet. KVK showcased its products and technologies that support family farming and safe food production.

- KVK staff attended 6 ATMA Monthly Technology Advisory (MTA) meetings during the report period.

- KVK conducted one day training programme on 'Recent trends and prospects of aquaculture' for ATMA Block Technology Managers (BTMs) from Ernakulam and Thrissur districts on 30th November 2014 at Narakkal Campus. Twenty six officials attended the training programme. The main objective was to update the knowledge of base level extension workers so as to strengthen ATMA fisheries activities.

- KVK experts attended ATMA Kisan Ghoshti programme at Kuzhuppilly

KVK Stall in the ATMA Technology Meet

and delivered a lecture on 'Pokkali finfish shrimp farming and organic vegetable and banana cultivation' on 26th February 2015.

Participation in exhibitions

- Three days exhibition organised by MES Engineering College as part of their golden jubilee celebrations, at its campus located at Kunnukara from 17th to 19th September 2014. Nearly 800 farmers and students visited the stall.

- Sixth edition of India International Food and Agri-Aqua Expo held at Kerala University of Fisheries and Ocean studies (KUFOS), Kochi from 30th October to 3rd November 2014. About 1000 farmers visited the stall.

- Global Agro meet - International Conference and Exposition on Value Added Agriculture and Food Processing held at Adlux International Convention Centre, Angamaly, Ernakulam, from 6th to 7th November 2014. The programme was organised by the Department of Agriculture, Government of Kerala in association with Kerala State Industrial Development Corporation (KSIDC) and Confederation of Indian Industry (CII). The meet was inaugurated by Hon'ble Union Minister for Agriculture Shri Radha Mohan Singh. KVK's stall showcased various technologies and products for Good Agricultural Practices-GAP and safe farming. Approximately 1500 number of farmers and extension personnel from all over the state visited the stall.

- Vasantholsavam 2014, organised jointly by District Administration and District Tourism Promotion Council at Jawaharlal Nehru International stadium ground, Kaloor, Kochi from 23rd December 2014 to 4th January 2015. Approximately 2500 farmers and public visited KVK stall.

- One day exhibition in connection with Ksheerasangamam organised by Dairy Development Department at NSS Auditorium, Perumbavoor on 29th December 2014.

- One day exhibition and Farmers Meet in connection with Platinum Jubilee Celebration of St. Stephen Higher Secondary School at St. Stephen Higher secondary School, Keerampara on 31st December 2014.

SWACHH BHARAT ABHIYAN

Central Marine Fisheries Research Institute with its headquarters at Kochi and 10 Regional/Research Centres all along the maritime states has chalked out elaborate plans to carry out the National Sanitation Campaign (*Swachh Bharat Abhiyan*)

Apart from above, all Heads of Divisions and Section-in-Charges have directed to depute 3-4 staff members/scholars from the concerned Division/ Sections to ensure wide participation and smooth conduct of the campaign.

Major Activities done during the Year 2014-2015

At CMFRI Hqrs., Cochin, *Swachh Bharat Abhiyan* began by organising an awareness campaign in the nearby Ponjikkara Ward of Mulavukadu Panchayat in Ernakulam. Dr. C. Ramachandran, Principal Scientist and Dr. Shyam S. Salim, Senior Scientist, CMFRI, Cochin made the preparatory visit to Ponjikkara to launch a monthly Campaign by CMFRI for *Swatch Bharat Abhiyan*. They approached Panchayat President Mr. Dinakaran, Vice-President Ms. Viji Shajan and Agricultural Officer Ms. Sharon Shelton to organise a cleanliness drive. Accordingly, cleanliness drive was organised from 2.30 PM onwards on 15.12.2014 at the entrance and precincts of

Dr. A. Gopalakrishnan, Director, CMFRI inagurates the programme by providing wastebins Center, Diu

CMFRI Director and employees form human chain on 1 January 2015

Cleaning the footpath in front of CMFRI

Staff members after cleaning of the terrace of Mumbai Research Centre

the Ayyappa Temple there and the programme ended at 4.30 P.M. Dr. A. Gopalakrishnan, Director, CMFRI inagurated the programme by providing two big wastebins for the temple. 52 Officers/Officials/ Research Scholars actively participated in the cleanliness drive. Besides the staff of CMFRI, the local *Kudumbasree* (SHG) members also participated in the programme actively.

Cleanliness drive carried out conducted on all Tuesdays from 2.30 p.m.-4.30 p.m. by cleaning of offices, corridors and premises, weeding out old records, disposing of old and obsolete furniture, junk materials. Announcement was made on all Tuesdays in this regard. Attention was also given to the better utilisation of bio-waste generated in the office.

Dumping of wastes in the office premises was stopped and the unused fish tanks and chemical glasswares were disposed in a proper manner.

To bring awareness among the general public, a human chain formation was formed on January 1, 2015. Placards were held to educate the importance of having a clean, green healthy India.

Cleaning of the Residential quarters of CMFRI was conducted in January 2015. Family members and employees were took part.

Cleaning of mangroves near KVK

Swachh Bharath Abhiyan at KVK Narakkal

Honourable Prime minister's call for Clean India (Swachh Bharath) activities initiated at KVK on 2nd October 2014 during Gandhi Jayanthi. The programme commenced by staff taking cleanliness oath (*Swachh Bharath Shapath*). Subsequently office and its premises were cleaned. The KVK team also cleaned mangrove forests located by the side of the backwaters in KVK campus. Huge quantities of plastic wastes were removed from the root zone of mangrove ecosystem which is the natural habitat and breeding space for brackishwater fish species.

OFFICIAL LANGUAGE IMPLEMENTATION

Bilingualisation and targets of correspondence

During the period cent percent issue of Section 3(3) documents in bilingual form (1052), reply of letters received in Hindi (984) and target of Hindi correspondence (64%) against the target of 55% were ensured.

Under bilingualisation programme during the period, 52 name plates, 18 rubber stamps, 27 Identity cards of staff members, 13 charts, certificates of training programmes,(CMFRI & KVK), banners of various programmes were prepared bilingually. New sign board of the Institute and ATIC Sales counter board were prepared in trilingual form.

Dr. A. Gopalakrishnan, Director, CMFRI receiving the Indira Gandhi Rajbhasha Puraskar from the Hon'ble President of India Shri Pranab Kumar Mukherjee

Book release on the occasion of National Scientific Official Language Seminar organised at CMFRI, Kochi on 29 April 2014

Meetings

I. Quarterly meetings of Official Language Implementation Committee

During the period, 4 meetings of the Official Language Implementation Committee of the Institute were conducted on 30.06.2014, 30.09.2014, 31.12.2014 and 31.03.2015.

II. Half yearly meeting of Town Official Language Implementation Committee

Attended meeting of Town Official Language Implementation Committee at Income Tax Office, Cochin on 05.12.2014.

Review of Official Language implementation activities of Regional/Research Centres

a) Monitoring and advice

The Official Language implementation activities of all Regional and Research Centres were reviewed and necessary suggestions were given for improvement.

b) Official Language inspection at Outstations

Official Language implementation activities of Mumbai Research Centre (20.08.2014), Veraval Regional Centre (By ICAR & Institute on 09.01.2015), Karwar Research Centre (25.02.2015) and Mangalore Research Centres (By ICAR & Institute on 28.03.2015) were inspected.

HRD Programmes

Hindi Workshops : In order to encourage the staff to work in Hindi and speak Hindi without hesitation Hindi workshops were conducted at Headquarters, Cochin as well as Outstations during the period as follows:

- Four Hindi workshops were conducted at Headquarters, Cochin on 29.04.2014 (Seminar on 'Sustainability aquatic environment') and Spoken Hindi Workshops on 01.09.2014, 18.12.2014 and 24.02.2015.
- One Day Scientific Hindi workshop on the subject 'Management of Marine Fisheries' at Visakhapatnam Regional Centre of CMFRI on 12.09.2014 and two days workshop on 20&21.03.2015.
- Hindi workshops at Tuticorine RC on Hindi noting & drafting and grammar on 22.07.2014 and 15.09.2015.
- Hindi workshop at Mangalore RC on 17.09.2014
- Hindi workshop at Karwar RC on 24.09.2014
- Hindi workshops at Mandapam Regional Centre on 27.06.2014, 30.09.2014 & 30.12.2014
- Hindi workshop at Veraval RC on Official Language Policy on 09.01.2015
- Hindi workshops at Madras Research Centre on 06.05.2014, 18.12.2014, 31.12.2014 & 31.03.2015.
- Hindi workshops at Mumbai RC on 16.09.2014 and 28.10.2014

Special focus to complete obligatory Training in Centres in Tamil Nadu

Seventeen Scientists, Technical and Clerical staff of Mandapam Regional Centre of CMFRI passed Hindi Praveen and Pragya courses and cash incentives were sanctioned. Total 10 staff members have enrolled for Prabodh and Praveen classes.

A word a Day

Under A word a day programme around 278 Hindi words with English equivalents were displayed on display board and circulated among staff members of Headquarters and Outstations.

Special incentive scheme

Under CMFRI special incentive scheme cash incentives were granted to 7 Officers and staff at Headquarters, Kochi.

Special incentive scheme - prize distribution

Extension programmes

I National Scientific Official Language Seminar

In order to disseminate scientific achievements through Official Language Hind, a National Scientific Seminar on the subject 'Approaches to aquatic ecosystem sustainability' was held at CMFRI Headquarters, Cochin on 29th April 2014. Scientists and Technical Officers of CMFRI including Regional and Research Centers and other Fishery Institutes participated in the seminar. Total 19 articles were presented and 10 posters were also exhibited in the seminar. Dr. A. Gopalakrishnan, Director, CMFRI distributed prizes to the winners and certificates to the participants of the seminar.

Hindi book *Bharat ki samudri sthaniyam* and special Hindi publication *Jaleeya paarithanthra ka tikaupan* were released on the occasion.

II. Hindi *Chethana Mas* Celebration

Hindi Chethana Mas was observed at CMFRI Headquarters, Cochin from 01 to 27 September, 2014 with various programmes and competitions in Hindi. Winners of competitions and overall contributors for the year were felicitated during the function.

Hindi Day/ Week/ Fortnight was observed in all Regional and Research Centres of CMFRI with various programmes.

III. Participation in Joint Official Language Celebration – 2014

Staff members of the Institute took part in various competitions of Joint Official Language celebration-2014 held at Cochin and won prizes and admiration certificates. Institute won Overall Trophy for Best participation.

IV. Participation in Regional Official Language Conference

Assistant Chief Technical Officer (Hindi) participated in the Annual Regional Official Language Conference held at Mangalore on 27.03.2015.

Dr. Sunita Devi Yadav, Dy. Director (Implemetation), D/o Official Language, Govt. of India, addressing the staff members during Hindi Chethana Mas celebration at CMFRI, Kochi

Hindi week competitions - a glance

Hindi workshop at Mumbai RC of CMFRI

Institute Publications (Hindi)

I. CMFRI Newsletter Cadalmin – Issue Nos. 139, 140, 141 & 142

II. Special Hindi Publication - *Jaleeya paarithanthra ka tikaupan*

III. Hindi book - *Bharat ki samudri sthaniyam*

E- Governance programmes continued

(i) New Website of CMFRI in Hindi

(ii) Use of bilingual software for fishing data collection

(iii) Digital display of Institute's Hindi publications

(iv) The Terminology Bank on fisheries.

(v) Hindi software Unicode in all computers

Awards

a. Indira Gandhi Rajbhasha Puraskar

CMFRI bagged the Indira Gandhi Rajbhasha Puraskar for the excellent work and commendable achievements in the implementation of Official Language Policy during the year 2012-13 for the category of Autonomous Bodies in Region 'C'.

CMFRI Participants receiving TOLIC award in the joint Official Language celebration of Kochi TOLIC

His Excellency President of India Shri Pranab Mukherjee awarded the Puraskar in the elegant function organized in Rashtrapati Bhavan, New Delhi on the occasion of Hindi Day on 14 September 2014. Dr. A. Gopalakrishnan, Director, CMFRI received the award. CMFRI is receiving this award for the third time.

b. Town Official Language Implementation Committee Awards

(i) CMFRI bagged Rajbhasha Rolling Trophy (1st Position) of Kochi Town Official Language Implementation Committee for the best implementation of Official Language during 2013-14.

(ii) Institute also bagged Rolling Trophy (3rd Position) for Best Hindi House Magazine (2013-14) for Newsletter – Cadalmin.

(iii) Institute won Overall Trophy for Best participation in the Joint Official Language Celebration-2014 conducted by Kochi Town Official Language Implementation Committee.

b. Karwar TOLIC Award

Karwar Research Centre of CMFRI bagged Award (1st Position) under Karwar Town Official Language Implementation Committee for outstanding performance of Official Language implementation for the year 2013-14.

PUBLICATIONS

Peer reviewed articles

J. Mar. Biol. Ass. India,

Ali, Sunil S., Krishnan, M., Jayasankar, J., Landge, Asha and Shenoy, Latha 2014. Evaluation of compliance of marine fisheries of Kerala with Article 8 of FAO CCRF. *Fish. Technol.,* 51: 167-172.

Arur, Anand, Krishnan, P., George, Grinson, Goutham, Bharathi, M. P., Kaliyamoorthy, M., Hareef, Baba, Shaeb, K., Suryavanshi, A.S., Srinivasa, Kumar, T. and Joshi, A. K. 2014. Influence of mesoscale eddies on a commercial fishery in the coastal waters of the Andaman and Nicobar Islands, India. *Int. J. Remote Sens.,* 35 (17): 6418-6443.

Asha, P.S., Diwakar, K., Santhanavalli, G. and Manissery, Mary K. 2015. Comparative distribution and habitat preference of the sea cucumber *Holothuria atra* (Jaeger) at protected and unprotected sites in Thoothukudi region of Gulf of Mannar, south-east coast of India. *Indian J. Fish*., 62 (1): 52-57.

Avinash, R., Desai, A.Y. and Ghosh, Shubhadeep 2014. Population dynamics of *Trichiurus lepturus* (Linnaeus, 1758) off Veraval. *Indian J. Fish.,* 61 (2): 14-18.

Baby Ushakiran, M.S., Merlee Teresa. Sr., M.V and Kaladharan, P. 2014. A review on resources, cultivation and utilization of marine macroalgae in India. *Seaweed Res. Utiln*., 36 (1&2): 114- 125.

Basheer, V.S., Mohitha, C., Vineesh, N., Divya, P.R., Gopalakrishnan, A. and Jena, J.K. 2015. Molecular phylogenetics of three species of the genus *Rastrilliger* using mitochondrial DNA markers. *Mol. Biol. Rep.,* 42 (4): 873-879.

Behera, Pralaya Ranjan, Menon, Muktha and Ghosh, Shubhadeep. 2014. Occurrence of Pacific Gregory, *Stegastes fasciolatus* (family Pomacentridae) off Visakhapatnam, east coast of India. *Mar. Biodivers. Rec.,* (7): 1-4. e122.

Bhat, Ajaz Ali, Haniffa, M. A., Milton, M. James, Ahmad Paray, Bilal, Divya, P.R. and Gopalakrishnan, A. 2014. Genetic variation of striped snakehead (*Channa striatus* Bloch, 1793) populations using random amplified polymorphic DNA (RAPD) markers. *Int. J. Biodivers.Conserv.,* 6(5): 363-372; DOI: 10.5897/IJBC2013.0649.

Bineesh, K.K., Akhilesh, K.V., Sajeela, K.A., Abdussamad, E.M., Gopalakrishnan, A., Basheer,V.S. and Jena, J.K. 2014. DNA barcoding confirms the occurrence rare elasmobranchs in the Arabian Sea of Indian EEZ. *Middle East J. Sci. Res.,* 19 (9): 1266-1271.

Bineesh, K.K., Akhilesh, K.V., Abdussamad, E.M., Pillai, N.G.K., Thiel, R., Jena, J.K. and Gopalakrishnan, A. 2014. Redescriptions of *Chelidoperca investigatoris* (Alcock, 1890) and *Chelidoperca occipitalis* Kotthaus, 1973 (Perciformes: Serranidae) from the south-west coast of India. *Indian J. Fish*., 61 (4): 118-123.

Bineesh, K.K., Akhilesh, K.V., Abdussamad, E.M. and Prakasan, D. 2014. Seamount associated fishery of south-west coast of India - a preliminary assessment. *Indian J. Fish*., 61 (3): 29-34.

Bineesh, K.K., Akhilesh, K.V., Gomon, M.F., Abdussamad, E.M., Pillai, N.G.K. and Gopalakrishnan, A. 2014. Redescription of *Chlorophthalmus corniger*, a senior synonym of *Chlorophthalmus bicornis* (Family: Chlorophthalmidae). *J. Fish Biol.,* 84: 513-522.

Bineesh, K.K., Akhilesh, K.V., Gopalakrishnan, A. and Jena, J.K. 2014. *Plectranthias alcocki,* a new anthiine fish species (Perciformes: Serranidae) from the Arabian Sea, off southwest India. *Zootaxa,* 3785 (3): 490-496.

Bineesh, K.K., Joshi, K.K., Abdussamad, E.M., Prakasan, D. and Akhilesh, K.V. 2014. Report of silverstripe blassop, *Lagocephalus sceleratus* (Gmelin, 1789) (Tetraodontidae) from south-west coast of India. *Indian J. Fish*., 61 (2): 143-145.

Chakraborty, Kajal, Chakkalakal, S.J. and Joseph, D. 2014. Response of pro-inflammatory prostaglandin contents in anti-inflammatory supplements from green mussel *Perna viridis* L. in a time-dependent accelerated shelf-life study. *J. Funct. Food*, 7: 527-540.

Chakraborty, Kajal, Joseph, D. and Chakkalakal, S.J. 2014 Effect of natural additives on the fatty acid signatures of green mussel *Perna viridis* L. in a time-dependent accelerated shelf-life study. *J. Food Quality,* 37: 415–428.

Chakraborty, Kajal , Joseph, D. and Chakkalakal , S. J. 2014.Toxicity profile of a nutraceutical formulation derived from green mussel *Perna viridis. BioMed Res. Int.,* 2014, dx.doi.org/10.1155/2014/471565

Chakraborty, Kajal, Thilakan, Bini and Raola,Vamshi K. 2014. Polyketide family of novel antibacterial 7-O-methyl-5'-hydroxy-3'-heptenoate macrolactin from seaweed associated *Bacillus subtilis* MTCC 10403. *J. Agri. Food Chem.,* 62 (50): 12194-208

Metapenaeus dobsoni (Miers 1878) from Kerala, south-west coast of India. *Indian J. Fish.,*

Plesionika quasigrandis Chace, 1985 off Sakthikulangara, south-west coast of India. *Indian J. Fish.,*

Oplophorus gracilirostris from south-east and south-west coast of India using mitochondrial genetic marker

Chandra Prakash, M.P., Singh, Kohli, Dube, Kiran, Rani, Babitha A.M., Roy, S. Dam, Raju, K.D. and Pawar, N. A. 2014. Studies on captive breeding and larval rearing of *Danio aequipinnatus* (McClelland, 1839). *Indian J. Anim. Res*., 48(4): 379-383.

Cheng, S.H., Anderson Frank E., Bergman A., Mahardika G.N., Muchlisin, Z.A., Dang B.T., Calumpong, H.P., Mohamed, K.S., Sasikumar, Geetha, Venkatesan V. and Barber, P.H. 2014. Molecular evidence for co-occurring cryptic lineages within the *Sepioteuthis cf. lessoniana* species complex in the Indian and Indo-West Pacific Oceans. *Hydrobiologia,* 725 (1): 165-188.

Chinnadurai, S., Bhave, Vishal Jayant, Apte, Deepak and Mohamed, K.S. 2014. First record of long-tailed pelagic sea slug *Stylocheilus longicauda* (Gastropoda: Opisthobranchia) from southwest coast of India. *J.Mar. Biol. Ass. India*, 56 (2): 81-84.

Chinnadurai, S., Mohamed, K.S., Venkatesan, V., Jenni, B. and Kripa, V. 2014. Depuration of bacterial populations in the Indian backwater oyster *Crassostrea madrasensis* (Preston, 1916): Effects on surface and bottom held oysters. *J. Shellfish Res.,* 33 (2): 409-414.

Dash, Gyanaranjan, Raman, Ram Prakash, Pani Prasad, K., Makesh, M. Pradeep M.A. and Swatipriyanka Sen, Dash 2014. Evaluation of paraprobiotic applicability of *Lactobacillus plantarum*in improving the immune response and disease protection in giant freshwater prawn, *Macrobrachium rosenbergii* (de Man, 1879). *Fish Shellfish Immunol.,*

Dash, Gyanaranjan, Raman, Ram Prakash, Pani Prasad, K., Makesh, M., Pradeep, M.A., Swatipriyanka Sen, Dash 2014. Evaluation of *Lactobacillus plantarum* as a water additive on host associated microflora, growth, feed efficiency and immune response of giant freshwater prawn, *Macrobrachium rosenbergii* (de Man, 1879). *Aquacult. Res.,* 2014 doi: 10. 1111/are.12539

Dash, Gyanaranjan, Raman, Ram Prakash, Pani Prasad, K., Makesh, M., Pradeep, M.A. and Swatipriyanka Sen, Dash 2014. Evaluation of *Lactobacillus plantarum* as feed supplement on host associated microflora, growth, feed efficiency, carcass biochemical composition and immune response of giant freshwater prawn, *Macrobrachium rosenbergii* (de Man, 1879). *Aquaculture*, 432: 225- 236

Dinesh Kumar, S., Nair, Rekha J. and Kuriakose, Somy 2014. Midnight Snapper *Macolor macularis* (Perciformes: Lutjanidae) - a new record of snapper from Indian waters. *Marine Biodivers. Rec.,* 79 (32): 1-4.

Dineshbabu, A.P., Thomas, Sujitha and Vivekanandan, E. 2014. Assessment of low value bycatch and its application for management of trawl fisheries. *J.Mar. Biol. Ass. India*, 56 (1): 103-108.

Divya, P. R., Gopalakrishnan, A., Basheer, V. S., Swaminathan, R., Mohitha, C., Joy, L., Kumar, R and Jena, J.K. 2015. Mitochondrial ATPase 6/8 genes to infer the population genetic structure of silver pomfret fish *Pampus argenteus* along the Indian waters. *Mitochondrial DNA*, 26(2):189-194, Apr. 2015, DOI: 10.3109/19401736.2013.879655.

Gandhi, V., Venkatesan, V. and Ramamoorthy, N. 2014. Reproductive biology of the spotted scat *Scatophagus argus* (Linnaeus, 1766) from Mandapam waters, south-east coast of India. *Indian J. Fish*., 61(4): 54-58.

Geetha R., Narayanakumar, R., Shyam S. Salim, Aswathy, N., Chandrasekar, S., Srinivasa Raghavan, V. and Divipala, Indira 2014. Economic efficiency of mechanised fishing in Tamil Nadu – a case study in Chennai. *Indian J. Fish*., 61 (1): 31-35.

Ghosh, Shubhadeep, Rao, M.V. Hanumantha, Rohit, Prathibha, Rammohan, K. and Maheswarudu, G. 2014. Reproductive biology, trophodynamics and stock structure of ribbonfish *Trichiurus lepturus* from northern Arabian Sea and northern Bay of Bengal. *Indian J. Geo-Mar. Sci.,* 43 (5): 755-771.

Ghosh, Shubhadeep, Rao, M.V. Hanumantha, Satish Kumar, M., Uma Mahesh, V., Menon, Muktha, and Zacharia, P.U. 2014. *Curr. Sci.,* 107 (3): 515-521.

Ghosh, Shubhadeep. 2014. Fishery, reproductive biology and diet characteristics of Bombayduck *Harpadon nehereus* from the Saurashtra coast. *Indian J. Geo-Mar. Sci.,* 43 (3): 418-426.

Gopal, Nikita, Jeyanthi, P., Ashok, Arathy, Shyam S. Salim, Katiha, Pradeep K., Krishnan, M., Barik, Nagesh Kumar, Ganesh Kumar, B., Narayanakumar, R. and Sathiadhas, R. 2014. Fishers in post-harvest fisheries sector in India: An assessment of socio-economic status. *Fish. Technol*., 51: 213-219.

Gupta, K.S., Kizhakudan, Shoba Joe, Kizhakudan, Joe K., Yousuf, K.S.S.M and Raja, S. 2014. Preliminary observations on dominance of crustacean larvae in the diet of little tunny *Euthynnus affinis* (Cantor, 1849) caught off Chennai and Cuddalore coasts. *Indian J. Fish.,* 61 (2): 40-44.

Ho, H.C., Bineesh, K.K. and Akhilesh, K.V. 2014. Rediscovery of *Lophiodes triradiatus* (Lloyd, 1909), a senior synonym of *L. infrabrunneus* Smith and Radcliffe (Lophiiformes: Lophiidae). *Zootaxa,* 3786 (5): 587-592.

Jayakumar, R., Nazar, A.K.A., Tamilmani, G., Sakthivel, M., Kalidas, C., Ramesh Kumar, P., Rao, G. Hanumanta and Gopakumar, G. 2014. Evaluation of growth and production performance of hatchery produced silver pompano *Trachinotus blochii* (Lacépède, 1801) fingerlings under brackishwater pond farming in India. *Indian J. Fish*., 61 (3): 58-62.

Jeena, N. S., Gopalakrishnan, A., Radhakrishnan, E.V., Kizhakudan, Joe, K., Basheer, V.S., Asokan, P.K. and Jena, J.K. 2015. Molecular phylogeny of commercially important lobster species from Indian coast inferred from mitochondrial and nuclear DNA sequences. *Mitochondrial DNA*, Early Online: 1–10, DOI: 10.3109/19401736.2015.1046160.

Johnson, B. Vijayaragavan, K. and Kingsly, Immanuelraj 2015. Economic impacts of system of rice intensification (SRI) in India. *Green Farming*, 6 (1): 168-171.

Kaladharan, P., Asokan, P.K., Koya, Mohammed and Bhint, H.M. 2014. Plastic debris in the stomach of a Longman's Beaked Whale*, Indopacetus pacificus* (Longman, 1926) stranded off Sutrapada, Veraval, Saurashtra coast, India. *J. Mar. Biol. Ass. India*, 56 (2): 92-94.

Kamal, Sarma, Pal, A.K., George, Grinson and Baruah, Kartik 2015. Effect of sub-lethal concentration of endosulfan on lipid and fatty acid metabolism of spotted murrel, *Channa punctatus. J. Environ. Biol.,* 36: 451-454.

Kannan, K., Ranjith, L., John, S. and Joshi, K.K. 2014. First record of *Grammonus robustus* (Ophidiiformes: Bythitidae) from Indian waters. *Mar.Biodiv. Rec.,*7(57): 1-4.

Kathirvelpandian, A., Gopalakrishnan, A., Lakra, W.S., Krishna, G., Sharma, R., Musammilu, K. K., Basheer V. S.and Jena, J. K. 2014. Microsatellite Markers to determine population genetic structure in the golden anchovy, *Coilia dussumieri. Biochem. Genet., 52*(5-6): 296-309.

Kathirvelpandian, A., Gopalakrishnan, A., Lakra, W. S., Krishna, G., Sharma, R., Divya, P. R., Kumar, R and Jena, J.K. 2014. Mitochondrial ATPase 6/8 genes reveal genetic divergence in the *Coilia dussumieri* (Valenciennes, 1848) populations of north east and northwest coasts of India. *Mol. Biol. Rep., 41*(6), 3723-3731.

Kizhakudan, Joe K. 2014. Reproductive biology of the female shovel-nosed lobster *Thenus unimaculatus* (Burton and Davie, 2007) from north-west coast of India. *Indian J. Geo-Mar. Sci.,* 43 (6): 927-935.

Kizhakudan, Joe K. and Krishnamurthy, S. 2014. Complete larval development of *Thenus unimaculatus* Burton & Davie, 2007 (Decapoda, Scyllaridae). *Crustaceana*, 87 (5): 570-584.

Kizhakudan, Shoba Joe, Raja, S., Gupta, K.S., Vivekanandan, E., Kizhakudan, Joe K., Sethi, S.N. and Geetha, R. 2014. Correlation between changes in sea surface temperature and fish catch along Tamil Nadu coast of India - an indication of impact of climate change on fisheries. *Indian J. Fish.,* 61 (3): 111-115.

Kizhakudan, Shoba Joe 2014. Study on the growth of three species of silverbellies from the south-east coast of India. *Indian J. Geo-Mar. Sci.,* 43 (2): 263-270.

Kripa, V., Mohamed, K.S., Prema, D., Mohan, Anjana and Abhilash, K.S. 2014. *Indian J. Geo-Mar. Sci.,* 43 (5): 737-745.

Libini, C.L, Albert Idu, K.A., Manjumol, C.C., Kripa, V. and Mohamed, K.S. 2014. Growth and survival of the blacklip pearl oyster *Pinctada margaritifera* (Linnaeus) spat reared with various combinations of microalgae in different stocking densities. *J. Mar. Biol. Ass. India,* 56 (2): 5-10.

Mahesh, V., Swathi Lekshmi, P.S., Benkappa, S., Kumar Naik A.S., Kumar Jitendra and Reddy S. Vijay Kumar. 2014. Decision making behaviour of fisherwomen of Dakshina Kannada District of Karnataka - An empirical analysis. *Fish. Technol*., 51: 280-285.

Manojkumar, P.P., Vivekanandan, E., Zacharia, P.U., Nair, Rekha J. and Pavithran, P.P. 2014. Fishery of flatfishes with observations on the biology and stock assessment of the Malabar sole, *Cynoglossus macrostomus* (Norman, 1928) exploited off Kerala coast. *Indian J. Fish*., 61(4): 35-41.

Margaret Muthu Rathinam, A., Kizhakudan, Joe K., Vijayagopal, P., Jayasankar, Vidya, Leslie, V.A. and Sundar, R. 2014. Effect of dietary protein levels in the formulated diets on growth and survival of juvenile spiny lobster *Panulirus homarus* (Linnaeus). *Indian J. Fish*., 61 (2): 67-72.

Mohanty, Bimal , Mahanty, Arabinda, Ganguly, Satabdi , Sankar, T.V., Chakraborty, Kajal , Rangasamy, Anandan, Paul, Baidyanath., Sarma, Debajith, Mathew, Suseela, Asha, K.K. , Behera, Bijay, Aftabuddin, Md., Debnath, Dipesh, Vijayagopal, P., Sridhar, N., Akhtar, M.S., Sahi, Neetu, Mitra, Tandrima, Banerjee, Sudeshna , Paria, Prasenjit, Das, Debjit, Das, Pushpita, Vijayan, K. K. , Laxmanan, P.T. and Sharma, A.P. 2014. Amino acid compositions of 27 food fishes and their importance in clinical nutrition. *J. Amino Acids,* (ID 269797):1-7.

Mohitha, C., Joy, L., Divya, P. R., Gopalakrishnan, A., Basheer, V.S., Koya, M. and Jena, J. K. 2014. Characterization of microsatellite markers in silver pomfret, *Pampus argenteus* (Perciformes: Stromateidae) through cross-species amplification and population genetic applications. *J. Genet.*, 93, e89-e93.

Murugan, A., Vinod, K., Saravanan, K.R., Anbalagan, T., Saravanan, R., Sanaye, S.V., Mojjada, S.K., Rajagopal, S. and Balasubramanian, T. 2014. Diversity, occurrence and socio-economic aspects of snappers and job fish (Family: Lutjanidae) fisheries from Gulf of Mannar region, south-east coast of India. *Indian J. Geo Mar. Sci.,* 43 (4): 618-633.

Musammilu, K. K., Abdul-Muneer, P. M., Gopalakrishnan, A., Basheer, V. S., Gupta, H., Mohindra, V., Lal K.K. and Ponniah, A. G. (2014). Identification and characterization of microsatellite markers for the population genetic structure in endemic red-tailed barb, *Gonoproktopterus curmuca. Mol. Biol. Rep., 41*(5), 3051-3062.

Nair, Anusree V., Pradeep, M.A. and Vijayan, K.K. 2014. Molecular approach for the rapid detection of *Bacillus* and *Pseudomonas* genera-dominant antagonistic groups-from diverse ecological niches using colony multiplex PCR. *J. Industrial Microbiol. Biotechnol.,*

Nair, Rekha J., Dinesh Kumar, S., Kuriakose, Somy and Praveen, P. 2014. *J. Aqua. Biol. Fish.,* 2: 551-555.

Nair, Rekha J. and Gopalakrishnan, A. 2014. *Rev. Fish. Sci. Aqua.,* 22:175-183.

Najmudeen, T.M., Sathianandan, T.V. and Zacharia, P.U. 2014. Fleet optimization of trawl fishery along southwest coast of India using surplus production model. *J. Mar. Biol. Ass. India,* 56 (2):74-80.

Pillai, Lakshmi S., Kizhakudan, Shoba Joe, Radhakrishnan, E.V. and Thirumilu, P. 2014. Crustacean bycatch from trawl fishery along north Tamil Nadu coast. *Indian J. Fish.,* 61 (2): 7-13.

Pillai, Lakshmi, S., Kunhikoya., V.A. and Koya, K.P. Said 2014. Occurrence of the deepsea squat lobster *Eumnida funambulus* Gordon, 1930 in Kavaratti, Lakshadweep. *Indian J. Fish.,* 61 (3): 116-117.

Purushottama, G.B., Dineshbabu, A.P., Saravanan, R. and Rao, G. Syda, 2014. Study of seasonal abundance of finfish and shell fish seed resources at Shambhavi estuary, Karnataka. *Indian J. Fish.,*

Raja Swaminathan, T., Basheer, V.S., Gopalakrishnan, A., Sood, Neeraj and Pradhan, P. K. 2015. A new epithelial cell line, HBF from caudal fin of endangered yellow catfish, *Horabagrus brachysoma* (Gunther, 1864). *Cytotechnology*, DOI 10.1007/s10616-014-9804-2.

Rajool Shanis, C.P., Shyam S. Salim, Manjebrayakath, Hashim, Ganga, U., Manjusha, U. and Pillai, N.G.K. 2014. Deep-sea shrimp fishery operations in Kerala coast: Problems and prospects. *Int. J. Fish. Aquatic Stud*., 1 (6): 237-242.

Rajool Shanis, C.P., Shyam S. Salim, Sridhar, Nivedita and Pillai, N.G.K. 2014. Economic efficiency of deep sea shrimp fishery operations in Kerala. *J. Fish. Econ. Dev.,* 15 (1): 1-13.

Ramesh Kumar P., Abdul Nazar, A K., Jayakumar, R. ,Tamilmani, G. ,Sakthivel, M., Kalidas, C., Balamurugan, V., Sirajudeen, S., Thiagu, R. and Gopakumar, G. 2015. *Amyloodinium ocellatum* infestation in the broodstock of silver pompano *Trachinotus blochii* (Lacepède, 1801) and its therapeutic control. *Indian J. Fish.,*

Ramesh Kumar, P., Kalidas, C., Tamilmani, G., Sakthivel, M., Nazar, A.K.A., Maharshi, V.Ashok, Rao, S.K., Srinivasa and Gopakumar, G. 2014. Microbiological and histopathological investigations of *Vibrio alginolyticus* infection in cobia *Rachycentron canadum* (Linnaeus, 1766) cultured in sea cage. *Indian J. Fish.,* 61(1) : 124-127.

Ranjan, Ritesh, Xavier, Biji, Dash, Biswajit, Edward, Loveson, Maheswarudu, G. and Rao, G. Syda 2014. Domestication and brood stock development of the orange spotted grouper, *Epinephelus coioides* (Hamilton, 1822) in open sea cage off Visakhapatnam coast. *Indian J. Fish*., 61 (1): 21-25.

Remya, R., Vivekanandan, E., Sreekanth, G.B., Ambrose, T.V., Nair, Preetha G., Manjusha, U., Thomas, Saiby and Mohamed, K.S. 2014. Stock structure analysis of Indian mackerel *Rastrelliger kanagurta* (Cuvier, 1817) from south-east and south-west coasts of India using truss network system. *Indian J. Fish*., 61 (3): 16-19.

Renjith, Vishnu, Radhan, Divya, David, Thresyamma, Kamal, Sarma, Grinson George, Prabhakar, Shirodkar and Ponnumony, Vethamony 2015. Influence of natural and anthropogenic factors on the water quality of the coastal waters around the south Andaman in the Bay of Bengal. *Nat. Hazards,* DOI10.1007/s11069-015-1715-9

Roy T.S.C., Gopalakrishnan, A., Muneer, P.M.A., John, L., Musammilu, K.K. and Basheer, V.S. 2014. Resolution of taxonomic ambiguity in groupers (Pisces: Serranidae) by the random amplified polymorphic DNA (RAPD) technique. *Indian J. Fish., 61(2): 28-34, 2014.*

Sadhu, N., Sharma S.R., Krupesha, Joseph, Shoji, Dube, P.N. and Philipose, K.K. 2014. Chronic stress due to high stocking density in open sea cage farming induces variation in biochemical and immunological functions in Asian seabass (*Lates calcarifer*, Bloch). *Fish Physiol. Biochem.*, 40:1105–1113.

Sahoo, A.K., Thakur, P.C., Shankar, K.M., Mohan, C.V., Sharma, S.R., Krupesha and Corsin, F. 2015. Histopathological findings on innate responses of white spot disease positive *Penaeus monodon* (Fabricius) under semi-intensive culture. *J. Fish. Dis.*, 38: 91-95.

Saji Kumar, K.K., Ragesh, N. and Mohamed, K.S. 2014. Behaviour of short-finned pilot whales *Globicephala macrorhynchus* (Gray, 1846) (Mammalia: Cetartiodactyla: Delphinidae) in the Southeastern Arabian Sea. *J. Threatened Taxa,* 6 (11): 6488-6492.

Samal, Amir Kumar, Nazar, A.K.A., Jayakumar, R., Tamilmani, G., Sakthivel, M., Rajendran, P. and Gopakumar, G. 2014. Musculoskeletal abnormalities in hatchery reared silver pompano, *Trachinotus blochii* (Lacépède, 1801). *Indian J. Fish*., 61 (3): 122-124.

Sanaye, S.V., Dhaker, H.S., Tibile, R.M. and Mhatre, V.D. 2014. Effect of green water and mixed zooplankton on growth and survival in Neon Tetra, Paracheirodon innesi (Myers, 1936) during larval and early fry rearing. *Int. J. Biological Food, Vet. Agricult.Eng.*, 8 (2): 21-25.

Sekar, M., Alam, A., Suresh, E., Patchala, S.R., Kathirvelpandian, A., Chaudhari, A. and Krishna, G. 2014. Genetic diversity among three Indian populations of black tiger shrimp *Penaeus monodon* (Fabricious, 1798) using microsatellite DNA markers. *Indian J. Fish*., 61(3): 45-51.

Sekar, M., Sigh, S. D. and Gupta, S. 2014. Cloning and characterization of *Pangasianodon hypophthalmus* growth hormone gene and its heterologous expression. *Appl Biochem Biotechnol.,* (DOI 10.1007/s12010-014-0946-7).

Sekar, M., Singh, S.D., Raymond, J.A., Meena, D.K., Sivakumar, N., Suresh, E. and Kathirvelpandian, A. 2015. Growth promoting activity of *Pangasianodon hypophthalmus* recombinant growth hormone expressed in *Escherichia coli. Indian J. Fish*., 62 (1): 70-77.

Sharma, S.R., Krupesha, Pradeep, M.A., Jayasree Loka, Sadhu, N., Praveen, N. Dube and Philipose, K.K. 2014. Association of *Vibrio harveyi* in mortality of mangrove red snapper (*Lutjanus argentimaculatus*, Forsskål, 1775) cultured in open sea cages: a case of first record from India. *Indian J. Fish.,* 61(3): 118-121.

Shyam S. Salim, Kiran, Pramod R.B., Nisha, Elizabeth Joshua and Biju Kumar, A. 2014. Challenges in food security: The fisheries and aquaculture policy perspectives in India. *J. Aquatic Biol. Fish.,* 2 (1): 24-31.

Shyam S. Salim, Kripa, V., Zacharia, P.U., Sridhar, Nivedita and Ambrose, T.V. 2014. Climate change awareness, preparedness, adaptation and mitigation strategies: fisherfolk perception in Coastal Kerala. *J. Aquatic Biol. Fish.,* 2: 670-681.

Shyam S. Salim, Kripa, V., Zacharia, P.U., Mohan, Anjana, Ambrose, T.V. and Manju Rani, C.C. 2014. Vulnerability assessment of coastal fisher households in Kerala: A climate change perspective. *Indian J. Fish*., 61 (4): 99-104.

Shyam S. Salim, Sathianandan,T.V., Swathi Lekshmi, P.S., Narayanakumar, R., Zacharia, P.U., Rohit, Pratibha., Manjusha, U., Antony, Bindu, Safeena, P.K., Shridhar, Nivedita, Ramees Rahman, M., Jayakumar., Rajani, Kumar, Nimmy S. and Nimisha C.P. 2015. Assessment of fishers' perception in developing climate change adaptation and mitigation plans. *J. Mar. Biol. Ass. India*, 57 (1) : 5-14

Shyam S. Salim, Kripa, V., Zacharia, P.U., Shridhar, Nivedita and Ambrose, T.V. 2014.

. *J. Aquatic Biol. Fish.,* 61 (2): 670-681.

Shyam S. Salim., Aswathy, N., Vipinkumar, V.P. and Geetha, R. 2014. Economic externalities of low value fishes in trawl operations in Kerala. *Indian J. Fish.,* 61 (2): 103-107.

Sirajudheen, T.K., Shyam S. Salim, Biju Kumar, A. and Antony, Bindu 2014. Problems and Prospects of marine ornamental fish trade in Kerala, India. *J. Fish. Econ. Dev.,* 15 (1) : 14-30.

Sreekanth, G.B., Zacharia, P.U., Sathianandan, T.V., Thomas, Saiby, Manju Lekshmi and Singh, Narendra Pratap 2015. Combining surplus production and spectral models to define fishery management advisory - a case study using the threadfin bream fishery along Kerala coast. *Indian J. Fish*., 62 (1): 41-45.

Sreenath, K. R., Jasmine, S., Rani Mary George and Jose Kingsly 2015. Community structure and spatial patterns in hard coral biodiversity of Agatti Island, Lakshadweep, India. *Indian J. Fish.,* 62 (Accepted).

Suja, C.P., Sukumaran, N., Dharmaraj, S. and Meena Anu 2014. Effect of depuration of animals and use of antimicrobial agents on proliferation of cells and microbial contamination in *in-vitro* mantle explants culture of the abalone *Haliotis varia* (Linnaeus). *Indian J. Fish*., 61 (3): 93-98.

Sulochanan, Bindu, Dineshbabu, A.P., Saravanan, R., Bhat, G.S., and Lavanya, S. 2014. Occurrence of *Noctiluca scintillans* bloom off Mangalore in the Arabian Sea. *Indian J. Fish.,* 61 (1): 42-48.

Sundaram, Sujit 2014. Fishery and biology of *Sepia pharaonis* Ehrenberg, 1831 off Mumbai, northwest coast of India. *J. Mar. Biol. Ass. India*, 56 (2): 43-47.

Suresh, E., Reddy, A. K., Krishna, G., Sharma, R., Chaudhari, A., Sankar, M., Sekar, M. and Kathirvelpandian, A. 2015. Microsatellite DNA Analysis of giant freshwater prawn (*Macrobrachium rosenbergii*) from India. *The Israeli J. Aquacult., Bamidgeh,* IJA_67.2015.1070, 7 p.

Swathi Lekshmi, P.S, Lingappa, Chaniyappa, M. and Naik, Appaya, R. 2014. Kairampani - The traditional shore seine fishing of Karnataka. *Asian Agri-History*, 18 (4): 375-381.

Swathi Lekshmi, P.S., Vipinkumar, V.P., Mahadevaswamy, H.S. and Lingappa. 2014. Primary, secondary and tertiary sectors in marine fisheries of Karnataka, India: A socio-economic profile. *Asian Academic Res. J. Social Sci. Humanities,* 1 (21): 32-50.

Thomas, S., Dineshbabu, A.P. and Sasikumar, G. 2014. Gastropod resource distribution and seasonal variation in trawling grounds off Konkan Malabar region, eastern Arabian Sea. *Indian J.f Geo-Marine Sci.,* 43 (3): 384-392.

Venkatesan, V. and Kalidas, C. 2014. Effect of selected chemicals on inducing relaxation in the dog conch *Laevistrombus canarium* (Linnaeus, 1758). *Indian J. Fish*., 61(4): 131-133.

Venkatesan, V., Saravanan, R., Meenakshi, S., Umayaparvathi, S. and Umakalaiselvi, T. 2014. Antibacterial activity in the extracts of accessory nidamental gland of the Palk Bay squid *Sepioteuthis lessoniana* (Lesson, 1830) (Cephalopoda: Decapoda). *Indian J. Fish.,* 61 (4): 146-148.

Vij, S., Purushothaman, K., Gopikrishna, G., Lau, D., Saju, J. M., Shamsudheen, K. V., Vinaya Kumar, K., Basheer, V. S., Gopalakrishnan, A., Mohammad S. H., Sridhar S., Vinod R., Jena, J. K., Ponniah, A. G. and Orbán, L. 2014. Barcoding of Asian seabass across its geographic range provides evidence for its bifurcation into two distinct species. Front. Mar. Sci., 1: 1-14, doi: 10.3389/fmars.2014.00030

Viji, C.S., Chadha, N.K., Kripa, V., Prema, D., Chandra Prakash, Sharma, Rakesh, Jenni, B. and Mohamed, K.S. 2014. Can oysters control eutrophication in an integrated fish-oyster aquaculture system? *J. Mar. Biol. Ass. India*, 56 (2): 67-73.

Vinaya Kumar, V., Reddy, A.D., Choudhury, S.R., Balakrishna, C.H., Satyanarayana, Y., Nagesh, T.S. and Das, S.K. 2014. Morphometry and meristic counts of Bombayduck, *Harpodon nehereus* (Hamilton, 1822) along Sunderban region of West Bengal, India. *Proc. Int. Acad. Ecol. Environ. Sci.,* 4(3): 95-105

Vineesh, N., Mohitha, C., Bineesh, K.K., Kumar, R.G., Gopalakrishnan, A. and Basheer, V.S. 2014. DNA barcoding and taxonomic note on genus *Macolor* (Perciformes: Lutjanidae) from Indian waters. *J. Ocean Sci. Foundation*, 13: 16-26.

Vinod, K. Rani Mary George, Thomas, P.A., Mary K. Manisseri and G. Shaylaja. 2014. Diversity and distribution of shallow water sponges (Porifera) in the coastal waters from Enayam to Kollam, south-west coast of India. *Indian J. Fish.,* 61(3): 52-57.

Vipinkumar, V.P. and Asokan, P.K. 2014. A study of self help group dynamics of women in Malabar fisheries sector. *Indian Res. J. Extension Edu.*, 14 (2): 25-30.

Vipinkumar, V.P., Narayanakumar, R., Ramachandran, C., Shyam S. Salim and Swathilekshmi, P.S. and Johnson, B. 2014. An Information communication and technology module on impact of microfinance on coastal indebtedness in Indian marine fisheries sector. *J.f Aquatic Biol. Fish.,* 2(2): 879-890.

Vipinkumar.V.P, Shyam S. Salim, Pushkaran, K.N., Harshan, N.K., Salini, K.P. and Sunil, P.V. 2014. The role of self help groups in coastal indebtedness in marine fisheries sector - A case study from Kerala, South India. *Indian J. Fish*., 61 (1):36-41.

Xavier, Biji., Jain, K.K., Pal, A.K., Sahu, N.P., Maheswarudu, G., Gal, D. and Kumar, S. 2014. Mixed feeding schedule of low and high protein in the diet of *Labeo rohita* (Hamilton) fingerlings: effect on growth performance, haemato-immunological and stress responses. *Aquacult. Nutr.,* Doi: 10.1111/anu.12286.

Technical articles

Anil M. K., Rani Mary George and Jasmine, S. 2014. Álgal culture techniques for larval rearing of pearl oysters' In: Manual on *Marine Designer Pearl Production –Science and Technology,* p. 29-41

Bhint, H.M. and Kaladharan, P. 2014 Veraval, Gujarat ke thateey samudr ke vileen poshak thathw aur pradhamik uthpadakatha. In: *Jaleey Parithanthru ka Tikaupan,* CMFRI Special Publication No.115: 161-163.

Chakraborty, Rekhadevi D., Maheswarudu, G., Radhkrishnan, E.V., Purushothaman, P., Kuberan, G., Sebastin, Jamon, and Thangaraja, R. 2014. Rare occurrence of blunthorn lobster *Palinustus waguensis* Kubo, 1963 from the south-west coast of India. ., 219: 25-26.

Chakraborty, Rekha Devi and Radhakrishnan, E.V. 2015. Taxonomy, Biology and Distribution of Lobsters. In: Joshi, K.K. Varsha, M.S., Sruthy, V.L., Susan, V. and Prathyusha, P.V. (eds.) *Summer school on "Recent advances in Marine Biodiversity, Conservation and Management"* CMFRI Lecture Notes Series No.1/2015, pp.100-110

Ganga, U. 2015. Aspects of taxonomy and life history traits of engraulids in the context of biodiversity conservation and fisheries management. In: Joshi, K.K. Varsha, M.S., Sruthy, V.L., Susan, V. and Prathyusha, P.V. (eds.) *Summer school on "Recent advances in Marine Biodiversity, Conservation and Management"* CMFRI Lecture Notes Series No.1/2015, p.138-141.

Geetha, R., Divipala, Indira, Vinod, K., Kizhakudan, Shoba Joe, Santhi, M. and Zacharia, P.U. 2014. Chennai matsyayan bandargah se samudri machali pakadne ki carbon padachihn. In: *Jaleey Parithanthru ka Tikaupan,* CMFRI Special Publication No.115 : 90-91.

George, Grinson. 2015. Ecological challenges of Island biodiversity. In: Joshi, K.K. Varsha, M.S., Sruthy, V.L., Susan, V. and Prathyusha, P.V. (eds.) Summer school on "Recent advances in Marine Biodiversity, Conservation and Management" CMFRI Lecture Notes Series No.1/2015, pp.212-214.

George, Grinson. 2015. Vulnerability assessment of biodiversity – case studies from an ecosystem perspective. In: Joshi, K.K. Varsha, M.S., Sruthy, V.L., Susan, V. and Prathyusha, P.V. (eds.) Summer school on "Recent advances in Marine Biodiversity, Conservation and Management" CMFRI Lecture Notes Series No.1/2015,pp.215-218.

George, Rani Mary and Jasmine, S. 2015. Scleractinian coral diversity in Indian reefs, their threats and conservation. In: Joshi, K.K. Varsha, M.S., Sruthy, V.L., Susan, V. and Prathyusha, P.V. (eds.) Summer school on "Recent advances in Marine Biodiversity, Conservation and Management" CMFRI Lecture Notes Series No.1/2015, pp.33-37

Ghosh, Shubhadeep, Rao, M.V.Hanumantha, Satish Kumar,M., Mahesh, Uma, V., Muktha, M. and Zacharia, P.U. 2014. Nizampattanam aur Machalipattanam ki samudri matsyiki mein carbon padachihn. In: *Jaleey Parithanthru ka Tikaupan,* CMFRI Special Publication No.115 : 82-89.

Gireesh, R., Varghese, Molly and Thomas, V.J. 2015. Phytoplankton – collection, estimation, classification and diversity. In: Joshi, K.K. Varsha, M.S., Sruthy, V.L., Susan, V. and Prathyusha, P.V. (eds.) Summer school on "Recent advances in Marine Biodiversity, Conservation and Management" CMFRI Lecture Notes Series No.1/2015, pp.24-28

Gopakumar, G., Nazar, A.K.A, Jayakumar, R., Johnson, B., Tamilmani, G. and Sakthivel, M. 2014. Samudri alankari machaliyom ka tikau vyavasay ka vikas. In: *Jaleey Parithanthru ka Tikaupan,* CMFRI Special Publication No.115 : 108-112.

Gopakumar, G., Nazar, A.K.A., Jayakumar, R., Tamilmani, G. and Sakthivel, M. 2014. Prajathi vividheekaran – thateey jalkrishi mein sthiratha sunischith karne ka upay. In: *Jaleey Parithanthru ka Tikaupan,* CMFRI Special Publication No.115 : 102-107.

Gopakumar, G., Nazar, A.K.A., Jayakumar, R., Tamilmani, G. and Sakthivel, M. 2014. Strategies and way forward to augment seafood production through finfish mariculture. *Mar. Fish. Infor. Serv., T & E Ser., 219 : 3-7.*

Joseph, Imelda 2014. Tikau paristhithik jalkrishi vyavasthayem ek parichay. In: *Jaleey Parithanthru ka Tikaupan,* CMFRI Special Publication No.115 :92-97.

Jose, Josileen. 2015. Classification, biodiversity and conservation of marine crabs. In: Joshi, K.K. Varsha, M.S., Sruthy, V.L., Susan, V. and Prathyusha, P.V. (eds.) Summer school on "Recent advances in Marine Biodiversity, Conservation and Management" CMFRI Lecture Notes Series No.1/2015,pp.84-92

Jose, Josileen. 2015. Life cycle and biology of Portunid crabs In: Joshi, K.K. Varsha, M.S., Sruthy, V.L., Susan, V. and Prathyusha, P.V. (eds.) Summer school on "Recent advances in Marine Biodiversity, Conservation and Management" CMFRI Lecture Notes Series No.1/2015, p.93-99.

Joseph, Imelda 2014. Tikau paristhithik jalkrishi vyavasthayem ek parichay. In: *Jaleey Parithanthru ka Tikaupan*, CMFRI Special Publication No.115 :92-97.

Joshi, K. K. and Sreekumar, K.M. 2015. Basics of sample collection, preservation and species identification of finfish. In: Joshi, K.K. Varsha, M.S., Sruthy, V.L., Susan, V. and Prathyusha, P.V. (eds.) *Summer school on "Recent advances in Marine Biodiversity, Conservation and Management"* CMFRI Lecture Notes Series No.1/2015, p.134-137.

Joshi, K. K., Varsha, M.S. and Sruthy, V.L. 2015. Indian marine biodiversity – Status and challenges. In: Joshi, K.K. Varsha, M.S., Sruthy, V.L., Susan, V. and Prathyusha, P.V. (eds.) *Summer school on "Recent advances in Marine Biodiversity, Conservation and Management"* CMFRI Lecture Notes Series No.1/2015, pp.9-12.

Jaleey Parithanthru ka Tikaupan,

Jaleey Parithanthru ka Tikaupan

Kaladharan, P., Asokan, P.K. and Koya, A. Anasu 2014. Predation of droves of soldier crabs *(Dotilla myctiroides)* by red fire ants *Solenopsis invicta. Mar. Fish. Infor. Serv., T & E Ser.,* 220: 20-21.

Kaladharan, P., Siji, K., Asokan, P.K. and Kripa, V. 2014. Kadalundi jwaranadmukh mein Halophila poudhom ki shayya samudri jaivavividhatha ke liye anuyojy parithatnthru. In: *Jaleey Parithanthru ka Tikaupan*, CMFRI Special Publication No.115 : 155-158.

Kishore, T.G., Shiyas, C.A., Sivakumar, G., Nair, J. Rekha, Dinesh Kumar, S., Seetha, P.K., Sobhana, K.S., Najmudeen, T.M., Sajna, V.H. and Zacharia, P.U. 2014. *Mar. Fish. Infor. Serv, T & E Ser,* 220: 21-22.

Kizhakudan, Joe K., Goerge, Rani Mary, Narayanakumar, R., Varghese, Molly, Kuriakose, Somy, Jasmine, S., Sreenath, K.R. 2014. Samudri parithanthru ki jaivavividhatha aakalan ka mahathv. In: Jaleey Parithanthru ka Tikaupan, CMFRI Special Publication No.115: 13-19.

Kizhakudan, Joe K., Krishnamurthy, S., Jasper, B. and Thiagu, R. 2014. Jalavayu parivarthan aur maanaviy gathividhiyon ke prathi crustacea prajaathi ki subhedhyatha. In: Jaleey Parithanthru ka Tikaupan, CMFRI Special Publication No.115 : 76-81.

Kizhakudan, Joe K., Pillai,S.Lakshmi, Kizhakudan, Shoba Joe, Jayasankar Vidya, Margaret Muthu Rathinam, A., Divipala Indira, Manibal, C., Xavier, Joseph C., Thirumilu, P., Krishnamurthy, S. and Sundhar, R. 2014. Utharee Tamilnadu ke thateey kshethrom mein upalabdh mahachingad sampada aur unki jalkrishi ki sambhavanayem. In: Jaleey Parithanthru ka Tikaupan, CMFRI Special Publication No.115 : 122-129.

Kizhakudan, Shoba Joe, Divipala, Indira, Kizhakudan, Joe K., Dineshbabu, A. P., Yousuf, K.S.S.M., Gupta, K.S. and Jasper, B. 2014 Kovalam, Tamil Nadu ke thateey kshethrom mein upalabdh surmayi machali ke matsyayan sthal ka geospatial naksha. In: Jaleey Parithanthru ka Tikaupan, CMFRI Special Publication No.115 : 31-33.

Kripa, V., Nair, Preetha G., Dhanya, A.M., Pravitha, V.P., Abhilash, Mohamed, K.S., Abbas, A., Vijayan, Dhanesh, Vishnu, P.G., Mohan, Gishnu, Anilkumar, P.S. Khambadkar, L.R. and Prema, D. 2014. Microplastics in the gut of anchovies caught from the mud bank area of Alappuzha, Kerala. *Mar. Fish. Infor. Serv., T & E Ser.,* 219: 27-28.

Laxmilatha, P., Sruthy, T. S. and Varsha, M. S. 2015. Marine Protected Areas. In: Joshi, K.K. Varsha, M.S., Sruthy, V.L., Susan, V. and Prathyusha, P.V. (eds.) Summer school on "Recent advances in Marine Biodiversity, Conservation and Management" CMFRI Lecture Notes Series No.1/2015, pp.199-206

Laxmilatha, P. 2015. Vulnerable marine ecosystems (VMEs). In: Joshi, K.K. Varsha, M.S., Sruthy, V.L., Susan, V. and Prathyusha, P.V. (eds.) Summer school on "Recent advances in Marine Biodiversity, Conservation and Management" CMFRI Lecture Notes Series No.1/2015, pp.207-211

,

Maheswarudu, G., Rao, G. Sudhakara., Rajamani, M., Thangaraj Subramanian, V., Nair, K.R. Manmadhan, Saleela, K.N., Dhanwanthari, E., Paul, Miriam and Unnithan, A.K. 2014. Penaied prawn resources along the east coat of India during 1991 – 2011. , 219 : 8-14.

Mini, K.G. 2015.Monitoring and Quantifying marine fish landings in India: Survey design, sampling and estimation followed by CMFRI. In: Joshi, K.K. Varsha, M.S., Sruthy, V.L., Susan, V. and Prathyusha, P.V. (eds.) *Summer school on "Recent advances in Marine Biodiversity, Conservation and Management"* CMFRI Lecture Notes Series No.1/2015, pp.21-23.

Mini, K.G., Kuriakose, Somy and Sathianandan, T.V. 2014. . Samudri matsyiki ek tikau jeevikoparjan rozgar ke roop mein apnane mein badath adhyathan jan-ganana saankhyiki ki report. In: *Jaleey Parithanthru ka Tikaupan*, CMFRI Special Publication No.115: 20-24.

Mohamed, K.S. and Venkatesan, V. 2014 Bharat mein samudreey mrudukavachi ki vividhatha: 21 vim shatabdi mein upayojan, samrakshan evam jalavayu parivarthan. In: *Jaleey Parithanthru ka Tikaupan*, CMFRI Special Publication No.115 : 41-56.

Mohamed, K.S., Zacharia, P.U., Maheswarudu, G., Sathianandan, T.V., Abdussamad, E.M., Ganga, U., Pillai, S. Lakshmi, Sobhana, K.S., Nair, Rekha J., Jose, Josileen, Chakraborty, Rekha D., Kizhakudan, Shoba Joe and Najmudeen, T. M. 2014. Minimum Legal Size (MLS) of capture to avoid growth overfishing of commercially exploited fish and shellfish species of Kerala. *Mar. Fish. Infor. Serv., T & E Ser.,* 220: 3-7.

Nair, Rekha J. and Zacharia, P.U. 2015. An introduction to the classification of elasmobranchs In: Joshi, K.K. Varsha, M.S., Sruthy, V.L., Susan, V. and Prathyusha, P.V. (eds.) *Summer school on "Recent advances in Marine Biodiversity, Conservation and Management"* CMFRI Lecture Notes Series No.1/2015, p.118-133.

Najmudeen, T.M. and Zacharia, P.U. 2015, Classification of exploited demersal finfishes of India: Pigface breams, lizardfishes and eels. In: Joshi, K.K. Varsha, M.S., Sruthy, V.L., Susan, V. and Prathyusha, P.V. (eds.) *Summer school on "Recent advances in Marine Biodiversity, Conservation and Management"* CMFRI Lecture Notes Series No.1/2015, p.142-152.

Pillai, Lakshmi S. 2014. Stomatopod matsyiki sampada evam unki ahamiyath. In: Jaleey Parithanthru ka Tikaupan, CMFRI Special Publication No.115 : 25-27.

Pillai, S Lakshmi. 2015. Inshore shrimps – Family, genera and species of commercial importance in India. In: Joshi, K.K. Varsha, M.S., Sruthy, V.L., Susan, V. and Prathyusha, P.V. (eds.) *Summer school on "Recent advances in Marine Biodiversity, Conservation and Management"* CMFRI Lecture Notes Series No.1/2015, pp.54-71

Pillai, S Lakshmi. 2015. Biology of inshore shrimps. In: Joshi, K.K. Varsha, M.S., Sruthy, V.L., Susan, V. and Prathyusha, P.V. (eds.) *Summer school on "Recent advances in Marine Biodiversity, Conservation and Management"* CMFRI Lecture Notes Series No.1/2015, pp.72-74

Prabhakar, R.V.D., Behera, Pralaya Ranjan., Edward, Loveson and Jeyabaskaran, R. 2014. Accidental catch of Long-snouted Spinner Dolphin, *Stenella longirostris* (Gray, 1828) at Dummulapeta, Andhra Pradesh. *Mar. Fish. Infor. Serv. T & E Ser.,* 220: 7-8.

Prema, D., Jeyabaskaran, R., Kaladharan, P., Khambadkar, L.R., Anilkumar, P.S., Nandakumar, A., Valsala, K. K. and Kripa, V. 2014. Water quality indexing of coastal waters off Cochin. *Mar. Fish. Infor. Serv., T & E Ser.,* 219: 15-16.

Prema, D., Kripa, V., Mohamed, K.S., Venkatesan, V., Valsala, K.K., Joseph, Mathew, Alloycious, P.S., Jenni, B., Anilkumar, P.S., Mohan, Anjana, Bose, John, Saji Kumar, K.K. and Ragesh, N. 2014. Bharath ke dakshin-paschim that ke Ashtamudi cheel mein avasad aur pani ki gunatha ke parivesh mein seepi samstahrom ka nirdharan. In: Jaleey Parithanthru ka Tikaupan, CMFRI Special Publication No.115 : 133-138.

Pugazhendi, D. 2014. Comparative study of marine fisher-folk census 2005 and 2010 of Puducherry. *Mar. Fish. Infor. Serv., T & E Ser.*, 220 : 14-17.

Ragesh, N., Saji Kumar, K.K., Remya, R., Sasikumar, Geetha, Koya, K.P. Said and Mohamed, K.S. 2014. Scope for mechanized fishing of teleosts with light attraction in Southeastern Arabian Sea. *Mar. Fish. Infor. Serv., T & E Ser.,* 219 : 21-23.

Saravanan, Raju and Ramamoorthy, N. and George, Rani Mary 2014. Samudri paryavaran thanthr ka prakary aur samudri jaivavidhatha. In: *Jaleey Parithanthru ka Tikaupan*, CMFRI Special Publication No.115 : 159-160.

Mar. Fish. Infor. Serv.

Jaleey Parithanthru ka Tikaupan

Shyam S. Salim, Rahman, Ramees M. 2014. Market structure analysis of fish markets in Ernakulam District. *Mar. Fish. Infor. Serv., T & E Ser.,* 220 : 22-24.

Shyam S. Salim and Antony, Bindu. 2015. Marine fisheries trade in India: Perspectives and paradigms. In: Joshi, K.K. Varsha, M.S., Sruthy, V.L., Susan, V. and Prathyusha, P.V. (eds.) *Summer school on "Recent advances in Marine Biodiversity, Conservation and Management"* CMFRI Lecture Notes Series No.1/2015, pp.13-20.

Shyam S Salim, Nivedita Shridhar, and Ramees Rahman .M .2015. Economic valuation of marine ecosystem services: methodological issues and challenges. In: Joshi, K.K. Varsha, M.S., Sruthy, V.L., Susan, V. and Prathyusha, P.V. (eds.) Summer school on "Recent advances in Marine Biodiversity, Conservation and Management" CMFRI Lecture Notes Series No.1/2015, pp.164-173.

Shyam S. Salim and Manjusha, U. 2015. Climate change impacts: Implications on marine resources and resource users. In: Joshi, K.K. Varsha, M.S., Sruthy, V.L., Susan, V. and Prathyusha, P.V. (eds.) Summer school on "Recent advances in Marine Biodiversity, Conservation and Management" CMFRI Lecture Notes Series No.1/2015,pp.174-186.

Sijo Paul and Hezhakiel, K. C. 2014. Paired and un-paired trawling at Munambam F.H. and Munambam Mini Harbour. *Mar. Fish. Infor. Serv., T & E Ser.*, 219 : 23-25.

Sivadas, M., Sathakathullah, S.M., Suresh Kumar, K. and Kannan, K. 2014. Bharath ke dakshin poorv that par kava kava machali (Euthinnus affinis) ka vidohan aur iskaa jeevavijnan. In: *Jaleey Parithanthru ka Tikaupan*, CMFRI Special Publication No.115 : 34-40.

Sobhana, K.S. 2015. Development of marine fish cell lines and stem cell lines: applications in mariculture and biodiversity conservation. In: Joshi, K.K. Varsha, M.S., Sruthy, V.L., Susan, V. and Prathyusha, P.V. (eds.) Summer school on "Recent advances in Marine Biodiversity, Conservation and Management" CMFRI Lecture Notes Series No.1/2015, pp.190-194.

Sobhana, K.S. 2015. Marine microbial diversity. In: Joshi, K.K. Varsha, M.S., Sruthy, V.L., Susan, V. and Prathyusha, P.V. (eds.) Summer school on "Recent advances in Marine Biodiversity, Conservation and Management" CMFRI Lecture Notes Series No.1/2015, pp.195-198.

Srinivasa Raghavan, V. and Vidya Jayasankar 2014. Jal krishi prajathi ke anuvamshik sudhar ke liye jaiv proudhyogiki upakaranom ka prayog. In: *Jaleey Parithanthru ka Tikaupan,* CMFRI Special Publication No.115 : 113-115.

Sukumaran, Sandhya and Gopalakrishnan, A. 2015. Molecular taxonomy – Applications, limitations and future. In: Joshi, K.K. Varsha, M.S., Sruthy, V.L., Susan, V. and Prathyusha, P.V. (eds.) Summer school on "Recent advances in Marine Biodiversity, Conservation and Management" CMFRI Lecture Notes Series No.1/2015, pp.157-161.

Sukumaran, Sandhya and Gopalakrishnan, A. 2015. Integrative taxonomy – Methods and applications In: Joshi, K.K. Varsha, M.S., Sruthy, V.L., Susan, V. and Prathyusha, P.V. (eds.) Summer school on "Recent advances in Marine Biodiversity, Conservation and Management" CMFRI Lecture Notes Series No.1/2015, pp.162-163.

Supraba, V., Dineshbabu, A.P., Thomas, Sujitha, Rohit, Prathibha, and Rajesh, K.M. 2014. Aberrations in the feeding behaviour of the Indian Mackerel, *Rastrelliger kanagurta. Mar. Fish,Infor,Serv., T & E Ser.,* 219: 26.

Sulochanan, Bindu, Lavanya, S. and Nataraj, G.D. 2014. . Samudri kude mein parivarthan aur is se that rekha mein honavala prabhav - Krnatak that ke sandarbh mein ek adhyayan. In: *Jaleey Parithanthru ka Tikaupan*, CMFRI Special Publication No.115: 164-173.

Varghese, Molly, Joshi, K.K., George, Rani Mary and Thomas, V.J. 2014. Bharath ke dakshin-paschim that ke padaplavakom ki jaivasoochi. In: *Jaleey Parithanthru ka Tikaupan*, CMFRI Special Publication No.115: 139-141.

Varghese, Molly, Thomas, V. J. and Susan, V. 2015. Collection and estimation of zooplankton. In: Joshi, K.K. Varsha, M.S., Sruthy, V.L., Susan, V. and Prathyusha, P.V. (eds.) *Summer school on "Recent advances in Marine Biodiversity, Conservation and Management"* CMFRI Lecture Notes Series No.1/2015, pp.29-

Vase, Vinay Kumar, Rajesh, K.M., Sampath Kumar, G. and Rohit, Prathibha 2014. Sea erosion impact at Yermal, Dakshina Kannada, Karnataka. *Mar.Fish.Infor.Serv. T & E Ser.* 219: 27.

Veena, S. and Kaladharan, P. 2014 Nayee prajathiyom ke pravesh se parithanthr mein parivarthan Visakhapatnam that ke paripreksh mein ek khoj. In: *Jaleey Parithanthru ka Tikaupan,* CMFRI Special Publication No.115 : 150-154.

Venkatesan, V. and Mohamed, K.S. 2015. Gastropod classification and taxonomy. In: Joshi, K.K. Varsha, M.S., Sruthy, V.L., Susan, V. and Prathyusha, P.V. (eds.) Summer school on *"Recent advances in Marine Biodiversity, Conservation and Management"* CMFRI Lecture Notes Series No.1/2015, pp.38-41

Venkatesan, V. and Mohamed, K.S. 2015. Bivalve classification and taxonomy. In: Joshi, K.K. Varsha, M.S., Sruthy, V.L., Susan, V. and Prathyusha, P.V. (eds.) *Summer school on "Recent advances in Marine Biodiversity, Conservation and Management"* CMFRI Lecture Notes Series No.1/2015, pp.42-48

Venkatesan, V. and Mohamed, K.S. 2015. Cephalopod classification and taxonomy. In: Joshi, K.K. Varsha, M.S., Sruthy, V.L., Susan, V. and Prathyusha, P.V. (eds.) *Summer school on "Recent advances in Marine Biodiversity, Conservation and Management*" CMFRI Lecture Notes Series No.1/2015, pp.49-53

Vijayagopal, P. 2015. Biodiversity, biotechnology and biomimicry In: Joshi, K.K. Varsha, M.S., Sruthy, V.L., Susan, V. and Prathyusha, P.V. (eds.) Summer school on "Recent advances in Marine Biodiversity, Conservation and Management" CMFRI Lecture Notes Series No.1/2015, pp.153-156

Viji, C.S., Mohamed, K.S., Kripa, V., Prema, D., Sharma, Rakesh and Jenni, B. 2014. Oysters improve growth of fish in an integrated aquaculture system in a tropical estuary. *Mar. Fish. Infor. Serv., T & E Ser.,* 220: 10-14.

Zacharia, P.U., Kizhakudan, Shoba Joe, Sobhana, K.S., Manojkumar, P.P., Thomas, Sujitha, Nair, Rekha J., Najmudeen, T.M., Muktha, M., Purushottama, G.B., Dash, Swatipriyanka Sen, Santhosh, B., Ranjith, L., Saravanan, Raju and Yousuf, K.S.S.M. 2014. Bhaaratheey vanya jeev (Samrakshan) adhiniyam ke thahath samrakshith upasthimeen prajathiyon kaa vivaran. In: *Jaleey Parithanthru ka Tikaupan*, CMFRI Special Publication No.115 : 28-30.

Popular articles

Dineshbabu, A.P., Thomas, Sujitha and Rohit, Pratibha. 2014. GIS-based spatial data analysis for marine fisheries management as a prerequisite for mariculture development. *Fishing Chimes*, 33 (10-11): 91-93.

George, Grinson and Gopalakrishnan, A. 2015. Central Marine Fisheries Institute – Leading the way in Tropical Marine Fisheries Resource, In: *Padma Vibhushan Prof. M.S. Swaminathan Felicitation Programme.*All India Association of ICAR Pensioners, Souvenir, pp. 119-122

Gopalakrishnan, A. and George, Grinson 2014. Tropical Marine Fisheries - Role of Central Marine Fisheries Research Institute in Research and Development: Achievements, Ongoing Activities and the Way Forward. *In: 10th Indian Fisheries and Aquaculture Forum towards Responsible Aquaculture and Sustainable Fisheries Souvenir*, pp. 14-20

Gopalakrishnan, A. and George, Grinson 2014. Empowering the marine fisheries sector with related research and development technologies - CMFRI's initiatives and plans. *Fishing Chimes,* 34 (1): 29-33.

Gopalakrishnan, A. and Mohamed, K.S. 2015. A Good Catch – MSC Certification of *Paphia malabarica*, the short-necked or yellow-foot clam of Ashtamudi Estuary. In: *Rahat Bano (ed.) Times Higher Education - A Guide to Opportunities in India and Abroad, pp. 174-175, The Times of India, New Delhi 110 002.*

Jeyabaskaran, R. Dolphin sightings now common on Kochi coast. *Deccan Chronicle,* 21st August, 2014.

Nightingale B., Krishnan, M., Mahapatra, B.K. and Pawar, N.A. 2014. Women empowerment through Ornamental Fish Cooperative Societies in West Bengal, with reference to South 24 Parganas district. *Fisheries Science*, 34 (7): 43-46.

Sasikumar, Geetha, Sampath Kumar, G., Shridhara, B., Nataraja, G.D., Rohit, Prathibha, Mohamed, K.S., Asokan, P.K. and Karamathulla, S. P. 2014. Demonstration of Mussel farming in Karnataka: A success story. *Fishing Chimes*, 34 (4): 31-33.

Shyam S. Salim, 2014. Fisheries trade perspectives in India: Need for improved domestic marketing and challenges ahead. *19th India International Seafood Show 2014, Souvenir*: 118-132.

Singh, Ram, Pandey, P.K., Krishnan, M. and Shyam S. Salim .2014. Promoting Aquaculture in Chhattisgarh. *Geospatial Today*, 28 : 42-44.

Books

Dineshbabu, A.P., Sasikumar, Geetha, Rohit, Pratibha, Thomas, Sujitha, Rajesh, K.M. and Zacharia, P.U. 2014. *Methodologies for studying finfish and shellfish biology.* CMFRI-NICRA Publication No.2. Central Marine Fisheries Research Institute, Kochi, 91 pp.

Kiruba Sankar R., Krishnan, P., George, Grinson., Kamal Sarma., Nagesh Ram., Ravi Kumar, T., Murugesan, S. and Dam Roy S. 2014. *Island fisheries development: A technology recipe for Nicobar Fishers*. Central Island Agricultural Research Institute, Port Blair, 106 pp.

Kiruba Sankar, R., Krishnan, P., George, Grinson, Sukham Molanisa Devi, Chandan Debnath, Benny Varghese, Bipul Chandra Ray, Ravi Kumar, T. and Dam Roy, S. 2014. *Compendium of aquaculture technologies for fish farmers of northeast India.* Central Island Agricultural Research Institute, Port Blair, 151 pp.

Kripa, V., Joshi, K.K., Sheela, P.J., Uma, E.K., Sasikala,E. and Joseph, V. Edwin 2014. *Jaleey Parithanthru ka Tikaupan,* CMFRI Special Publication No.115: 1-173.

Nair, Rekha J. and Somy Kuriakose. 2014. *CMFRI Special Publication* Central Marine Fisheries Research Institute, Kochi, 152 pp.

Central Marine Fisheries Research Institute, Kochi, 222 pp.

Sathiadhas, R., Shyam S. Salim, and Narayanakumar, R. 2014. *Livelihood status of fishers in India.* Central Marine Fisheries Research Institute, Kochi, 311 pp.

Sasikumar, G., Mohamed, K.S., Rohit, Pratibha,. and Sampathkumar, G. 2015. *Policy guidance on cuttlefish fishery using Fish Aggregating Device. CMFRI Mar.Fish. Policy Ser.1*, 56 pp.

Book chapters

Antony, Bindu, Shyam, S. Salim and Rahman, M. Ramees 2014. In: *Sustainable Resource Management Tools and Techniques*. Cherian, Susan and Joseph, Anu and Vikraman, Nisha, (eds.) St. Teresa›s College, Ernakulam. pp. 75-81.

Barik, Nagesh Kumar, Kumar, Rakesh, Narayanakumar, R., Krishnan, M., Katiha, Pradeep K., Ponnusamy, K. and Shyam, S. Salim 2014. In: *Livelihood status of fishers in India.* Sathiadhas, R., Shyam, S. Salim and Narayanakumar, R,(eds.) Central Marine Fisheries Research Institute, Kochi, pp. 157-189.

Das, Madhumita and Dash, Biswajit. 2015. Coliform bacterial populations in aquatic environments. In: *Fish habitat and aquaculture.* Second Edition, Discovery Publishing House, New Delhi, India, pp. 184-195.

Das, Madhumita and Dash, Biswajit. 2015. Sustainable composting of aquatic weeds and excreta for utilization in aquaculture. In: *Fish habitat and Aquaculture.* Second Edition, Discovery Publishing House, New Delhi, India, pp. 83-95.

Ganesh Kumar, B., Shyam S. Salim and Katiha, Pradeep K. 2014. In: *Livelihood status of fishers in India*. Sathiadhas, R., Shyam, S. Salim and Narayanakumar, R. (eds.) Central Marine Fisheries Research Institute, Kochi, pp. 129-154.

George, Grinson 2014. Numerical modelling and satellite remote sensing as tools for research and management of marine fishery resources. In*: Remote sensing and modeling: Advances in coastal and marine resources*. Finkl, Charles W. and Makowski, Christopher, (eds.) Coastal Research Library, 9 Springer, pp. 431-452.

Gopal, Nikita, Shyam, S. Salim, Krishnan, M., Biradar, R. S., Katiha, Pradeep K., Barik, N.,Kumar, Rakesh, Sharma, Arpita and Ponnusamy, K. 2014. In: *Livelihood status of fishers in India.* Sathiadhas, R. and Shyam, S. Salim and Narayanakumar, R. (eds.) Central Marine Fisheries Research Institute, Kochi, pp. 247-279.

Jeyabaskaran, R. 2014. Relationship between oceanographic parameters and deep sea megafauna and marine mammals of Southern Ocean. In*: Scientific Report of Southern Ocean Expedition 2011*. National Centre for Antarctic Research, Ministry of Earth Sciences, Goa, India, pp. 63-70.

Joshi, K.K., Narayanakumar, R., George, Ranimary, Varghese, Molly, Jasmine, S., Srinath, K.R. Saravanan, S. Kuriakose, Somy, Antony, Geetha, Geetha, P.M. and George,Gimy. 2015. Biodiversity valuation of marine ecosystem of the south-west coast of India with special reference to Kerala coast. In: Laladhas K.P., Oommen V. Oommen and Sudhakaran P. R. (Eds.), *Biodiversity Conservation - Challenges for the Future*, p.183-193.

Kaladharan, P. and Baby Ushakiran, M.S. 2014. Halophytes- alternative food crops from saline and coastal habitats. In: *Climate Resilient Crops of Future.* Peter, K.V. (ed.) New India Publishing Agency, New Delhi. pp. 450.

Katiha, Pradeep K., Shyam S. Salim, Ganesh Kumar, B., Barik, Nagesh Kumar, Narayanakumar, R., Krishnan, M., Gopal, Nikita and Ponnusamy, K. 2014. In: *Livelihood status of fishers in India.* Sathiadhas, R., Shyam S. Salim and Narayanakumar, R. (eds.) Central Marine Fisheries Research Institute, Kochi, pp. 73-126.

Krishnan, M., Shyam, S. Salim, Narayanakumar, R., Barik, N. and Ponnusamy, K . 2014. Brackishwater aquaculture. In: *Livelihood status of fishers in India.* Sathiadhas, R., Shyam, S Salim and Narayanakumar, R. (eds.) Central Marine Fisheries Research Institute, Kochi, pp. 193-244.

Manjusha, U., Shyam S. Salim, Mohamed, K.S., Antony, Bindu, Sridhar, N. and Remya, R. 2014. In: *Sustainable resource management tools and techniques*. Cherian, Susan, Joseph, Anu and Vikraman, Nisha,(eds.) St. Teresa's College, Ernakulam. pp 102-109.

Ramees Rahman, M., Shyam S. Salim, Antony, Bindu 2014. Economic evaluation approach for assessing marine ecosystem in India. In: *Sustainable resource management tools and techniques*. Cherian, Susan, Joseph, Anu and Vikraman, Nisha, (eds.) St. Teresa's College, Ernakulam, pp 90-97.

Sathiadhas, R., Katiha, Pradeep, K., Shyam, S. Salim and Narayanakumar, R. 2014. In: *Livelihood status of fishers in India.* Sathiadhas, R., Shyam, S Salim and Narayanakumar, R. (eds.) Central Marine Fisheries Research Institute, Kochi, pp. 3-16.

Shridhar, Nivedita, Shyam S. Salim and Manjusha, U. 2014. Evaluating the multipronged services of mangroves in the dynamic coastal ecosystems In: *Sustainable resource management Tools and techniques*. Cherian, Susan, Joseph, Anu and Vikraman, Nisha, (eds.) St. Teresa's College, Ernakulam, pp. 82-89

Shyam S. Salim 2014. In: *Agro processing and value addition for entrepreneurship development*. Mangaraj, Shukadev and Patil, R. T. and Chandra, Pitam, (eds.) Satish Serial Publishing House, Delhi, pp. 191-207.

Shyam, S. Salim 2014. In: *Agro processing and value addition for entrepreneurship development*. Mangaraj, Shukadev and Patil, R. T. and Chandra, Pitam, (eds.) Satish Serial Publishing House, Delhi, pp. 209-231.

Shyam, S. Salim 2014. In: *Agro processing and value addition for entrepreneurship development*. Mangaraj, Shukadev, Patil, R. T. and Chandra, Pitam, (eds.) Satish Serial Publishing House, Delhi, pp. 149-170.

Shyam, S. Salim and Narayanakumar, R. 2014. In: *Livelihood status of fishers in India*. Sathiadhas, R., Shyam, S. Salim and Narayanakumar, R., (eds.) Central Marine Fisheries Research Institute, Kochi, pp. 49-70.

Shyam, S. Salim, Narayanakumar, R., Katiha, Pradeep K., Krishnan, M., Barik, N., Gopal, Nikita, Biradar, R. S., Sharma, Arpita and Ponnusami, K .2014. In: *Livelihood status of fishers in India.* Sathiadhas, R., Shyam, S. Salim and Narayanakumar, R., (eds.) Central Marine Fisheries Research Institute, Kochi, pp. 18-46.

Shyam, S. Salim, Sathiadhas, R. and Narayanakumar, R. 2014. In: *Livelihood status of fishers in India.* Sathiadhas, R, Shyam, S. Salim and Narayanakumar, R. (eds.) Central Marine Fisheries Research Institute, Kochi, pp. 283-311.

Conference/Workshop presentations

Abdussamad, E.M., Rohit, P. and Mini, K.G. 2014. Neritic tuna resources of Indian waters - yield trend, biology and population characteristics of major species. IOTC-*2014-WPNT-11*.

Divu, D., Murugan, Senthil, Loka, Jayasree, Sharma S.R., Krupesha, Rao, K. Srinivasa, Roshmon, T. and Philipose, K.K. 2014. Nursery rearing of marine high value finfish species in indoor rearing systems. In: *National Workshop on Marine Biodiversity and Climate change"*. Karwar Research Centre of CMFRI, 21-22 May 2014.

George, Grinson, Nair, Rekha J,. Kuriakose, Somy 2014. Impact of climate change on coral reef ecosystem of Andaman and Nicobar islands. In: *Delineating the Issues of Climate Change and Impacts to Marine Ecosystems: Bridging the Gap between Research, Assessment, Policy and Management*, Shanghai, China, 4-9 August 2014

Loka, Jayasree, Philipose, K.K., Sharma S.R., Krupesha, Fofandi, Mahendrakumar, Vaidya, N.G., Sadhu, Narasimhulu, Sonali, S.M. and Dube, Praveen N. 2014. Assessment of marine environment in the cage farm off Karwar. In: *National Workshop on Marine Biodiversity and Climate change.* Karwar Research Centre of CMFRI. 21-22 May 2014.

Mohamed, K.S. 2015. Future of India's marine fisheries. In: *102nd Indian Science Congress*, University of Mumbai, Mumbai, January 3-7, 2015.

Nair, Rekha J., Kuriakose, Somy, George, Grinson, Zacharia, P.U. and Gopalakrishnan, A. 2014. *Increased productivity and sea surface temperature results in better recruitment and spread of Indian oil sardine in Northern Indian Ocean*. Poster presented at Summer school by Integrated Marine Biogeochemistry and Ecosystem Research from 4-9 August 2014 China, Delineating the Issues of Climate Change and Impacts to Marine Ecosystems: Bridging the Gap between Research, Assessment, Policy and Management at Shanghai, China.

Nair, Rekha J. and Gopalakrishnan, A. 2014. "An Overview on the fishery and taxonomy of flatfishes of India". In: *9th International Flatfish Symposium.* The National Oceanic and Atmospheric Administration's Alaska Fisheries Science Center and the International Pacific Halibut Commission at Cle Elum, Washington, USA, 10 November 2014.

Philipose, K.K., Loka, Jayasree, Sharma, Krupesha S.R., Murugan, Senthil, Divu, D., Mahendrakumar, Fofandi, Vaidya, N.G., Sadhu N., Sonali, S.M. and Dube, Praveen N. 2014. Recent advances in open sea cage farming in India: an alternate livelihood opportunity for fishermen community. In: *National Workshop on Marine Biodiversity and Climate change.* Karwar Research Centre of CMFRI. 21-22 May 2014.

Pillai, Lakshmi S., Rohit, Pratibha, Dineshbabu, A.P., Kizhakudan, Shoba Joe, Thomas, Sujitha and Maheswarudu, G. 2014. Bycatch from tuna fishery and trawl operations along the southern peninsular India. *IOTC–2014–WPEB10–19 Rev_1:1-12.*

Raja, S., Geetha, R., Kizhakudan, Joe K. and Vivekanandan, E. 2014. Traditional knowledge among fishers of coastal Tamil Nadu with special reference to climate change. In: *National Symposium on Cultural Landscapes, Indigenous Knowledge and Biotechnological tools for Biodiversity conservation, CULINKBIOCON 2014*, Kongunadu Arts and Science College, Coimbatore.

Rohit, Prathibha, Jasmine, S. and Abdusamad, E.M. 2014. Distribution and fishery of the bullet tuna *Auxis rochei* (Risso, 1810) along the Indian Coast. *IOTC-2014-WPNT04-31.*

Saravanan, Raju, George, Rani Mary, Ramamoorthy, N., SayedSadiq, I. and Shanmuganathan, K. 2014. Intertidal beach-rock associated seaweed diversity along Nochiyurani coast of Gulf of Mannar. In: *National Seminar on Algae for Sustaibale Agricultural Production.* 29 – 30 September, 2014, Madurai, p. 99.

Saravanan,R., Joshi, K.K. and Rani Mary George 2014. Echinoderm diversity around Indian Coast. In: *National Workshop on Marine Biodiversity and Climate Change.* 21 - 22 May 2014, p. 5.

Saravanan, R., Vinod, K., Joshi, K. K.and James, D. B. 2015. Review on the status and diversity of Asteroid seastars in Gulf of Mannar. Regional Seminar on *Current status and Future prospect of Coastal and Marine Biodiversity in Gulf of Mannar*, 23 January 2015, Rameswaram. p. 40.

Sonali S.M., Vaidya, N.G., Loka, Jayasree, Sharma, Krupesha S.R. and Philipose, K.K.. 2014. Biodiversity studies in the marine farm off Karwar. . In: *National Workshop on Marine Biodiversity and Climate change.* Karwar Research Centre of CMFRI. 21-22 May 2014.

Sreenath, K.R., Kumar, S, Makwana, N.P. Koya, M., Gyanaranjan Dash, Swatipriyanka Sen, Dash, Mojjada, S.K., Shiju, P. and Zacharia, P.U. 2014. A projection of regional sea surface temperature increment under different climate change scenarios. In: *National Workshop on Marine Biodiversity and Climate change.* Karwar Research Centre of CMFRI. 21-22 May 2014.

Training manuals

Abdul Nazar, A.K., Jayakumar, R. and Chidambaram, P. 2014. Course manual on technological advancements in the seed production of marine finfish and shellfish. Central Marine Fisheries Research Institute, Mandapam, 244 pp.

Gopakumar, G., Abdul Nazar, A.K., Jayakumar, R., Tamilmani, G., Sakthivel, M., Madhu, K., Rema Madhu, Vijayagopal, P., Anil, M.K., Ignatius, Boby, Johnson, B. and Chidambaram, P. 2014. Training Manual on marine ornamental fish breeding and aquarium management techniques. Central Marine Fisheries Research Institute, Mandapam, 227 pp.

Joshi, K.K., Varsha, M.S., Sruthy, V.L., Susan, V. and Prathyusha, P.V. 2015. Summer School on Recent Advances in Marine Biodiversity Conservation and Management, CMFRI Lecture Note Series No.1/2015, Central Marine Fisheries Research Institute, Kochi, 272 pp.

S. Ramkumar, Sakthivel, M., Mhatre ,Vaibhav D. and Gopakumar, G. 2014. Dealing with marine mammals stranding in India. Training manual prepared under GOI-UNDP-GEF sponsored project 'Development of protocols and capacity building on stranding, beaching and post-mortem analysis of Cetaceans'. Central Marine Fisheries Research Institute, Kochi,102 pp.

M. Sakthivel, Ramkumar, S., Mhatre ,Vaibhav D. and Gopakumar, G. 2014. Species identification of marine mammals of India. Training manual prepared under GOI-UNDP-GEF sponsored project 'Development of protocols and capacity building on stranding, beaching and post-mortem analysis of Cetaceans'. Central Marine Fisheries Research Institute, Kochi, 119 pp. .

Sathainandan. T.V., Mini, K.G. and Kuriakose, Somy 2014. Training manual on Fish Stock Assessment and Management, Central Marine Fisheries Research Institute, Kochi, 150 pp.

Reports

Asokan, P.K., Kaladharan, P., Sanil, N.K., Binesh, C.P., Shamal, P., Mohamed, K. and Vijayan, K.K. 2014. *Report on Clam Mortality at Sal Estuary, Velim, Goa.* Submitted to Govt. of Goa.

CMFRI 2014.
Technical Report, Central Marine Fisheries Research Institute, Kochi, 63 pp.

CMFRI 2014. *Marine Fish Landings in India 2014.* Technical Report, Central Marine Fisheries Research Institute, Kochi.

Leaflets

Ganga, U., Jinesh P.T., Prakasan, D., Abdussamad, E.M and Rohit, Prathibha. 2014. The bane of juvenile fish catches.

Ignatius, Boby, Joseph, Shoji, Joseph, Imelda and Aswathy, N. 2014. Seed production and cage culture of pearl spot. (Malayalam)

Joseph, Imelda, Ignatius, Boby and Aswathy, N. 2014. Cage culture of grey mullet (*Mugil cephalus*). (Malayalam)

Joseph, Imelda, Ignatius Boby and Venugopalan, K.M. 2014. Cage culture of GIFT Tilapia: A farming option during monsoon season in traditional shrimp ponds.

Joseph, Imelda, Ignatius Boby and Venugopalan, K.M. 2014. Cage culture of GIFT Tilapia: A farming option during monsoon season in traditional shrimp ponds. (Malayalam)

Joseph, Imelda, Venugopalan, K.M. and Aswathy, N. 2014. Dismantling and re-assembling type cages for open water aquaculture. (Malayalam)

Joseph, Imelda and Ignatius Boby 2014. Culture of grey mullet (*Mugil cephalus*) in backwater cage.

Joseph, Imelda and Venugopalan, K.M. 2014. Dismantling and re-assembling type cages for open water aquaculture.

Jayakumar, R., Nazar, A.K.A., Tamilmani, G., Sakthivel, M. and Gopakumar, G. 2014. Farming of silver pompano *Trachinotus blochii* in coastal aquaculture ponds.

Kizhakudan, Shoba Joe, Purushottama, G.B., Nair, Rekha J.,Yousuf, K.S.S.M. and Zacharia, P.U. 2014. Save our sharks.

Kripa, V., Prema, D., Shyam, S. Salim, Alloycious, P.S., Ambrose, T.V., Bose, John and Zacharia, P.U. 2014. Climate change and the man (Malayalam)

Laxmilatha, P., Pattnaik, Phalguni, Rao, T.Nageswara, Rao, M. Prasada and Padmajarani, S. 2014.

Nazar, A.K.A., Jayakumar, R., Tamilmani, G., Sakthivel, M. and Gopakumar, G. 2014.

Purushottama, G.B., Kizhakudan, S.Joe and Zacharia, P.U. 2014. Save our sharkes (SOS). (in Marathi).

Sakthivel, M., Nazar, A.K.A., Jayakumar, R., Tamilmani, G. and Gopakumar, G. 2014.

Tamilmani, G., Nazar, A.K.A., Jayakumar, R., Sakthivel, M. and Gopakumar, G. 2014. Cage farming of cobia *Rachycentron canadum*.

Zacharia, P.U., Shyam, S. Salim, Najmudeen, T. M., George, Grinson, Nandakumar, A., Anilkumar, P.S. and Retheesh, T. 2014.

Zacharia, P.U., Shyam, S.Salim, George, Grinson and Najmudeen, T.M. 2014.

Posters

Laxmilatha, P., Pattnaik, Phalguni, Rao, T. Nageswara, Rao, M. Prasada and Padmajarani, S. 2014. CMFRI Poster No. 8/2015.

Pillai, Lakshmi S., Josileen, Jose, Maheswarudu, G., Thirumilu, P., Baby, P.K. and Radhakrishnan, M. 2014. *Portunid Crab Resources of India,* CMFRI Poster No. 5/2015.

.Sobhana, K. S., Zacharia, P. U., Kizhakudan, Shoba Joe, Mani, P. T., Seetha, P. K., Paul, Sijo, Dinesh Kumar, S., Manoj Kumar, P. P., Najmudeen, T. M., Nair, Rekha J., Thomas, Sujitha, Menon, Muktha, Purushothama, G. B. and Sen, Swathi Priyanka 2014. Elasmobranch resources of the southwest coast of India, Part 1 – Sharks. CMFRI Poster No.10/2014

Video

Venkatesan, V., Mohamed, K.S., Kripa, V., Venu, M.K. and John, Varghese 2014. Women Power Growth in Oyster Farming: Impact of ICAR's World Bank aided NAIP value-chain scheme on high value shellfishes.

Vipinkumar, V.P., Asokan, P.K, Mohamed, K.S. and Gopalakrishnan, A. 2014. Success Story of Women's Self Help Groups in Mussel farming in Kadalundi. Malayalam

Vipinkumar, V.P., Asokan, P.K., Mohamed, K.S.and Gopalakrishnan, A. 2014. Success Story of Women's Self Help Groups in Mussel farming in Kadalundi.

Vipinkumar, V.P., Asokan, P.K., Mohamed, K.S. and Gopalakrishnan, A. 2014. Kadalundi ke sambhukrishi mem sthreeyom ke swayam seva sangh ki vijayagadha. (Success Story of Women's Self Help Groups in Mussel farming in Kadalundi).

Vipinkumar, V.P., Mohamed, K.S., Asokan, P.K. and Gopalakrishnan, A. 2014. Awakening Saga of Women SHGs in Bivalve Farming in Kerala.

KVK Publications

Booklets

Shinoj Subramannian, Shoji Joy Edison and Suresh Kumar. B. 2015. Karshika Parisheelana Sahayi. Krishi Vigyan Kendra, Central Marine Fisheries Research

Institute, 62 pp.

Shoji Joy Edison and Shinoj Subramannian 2015. Veettuvalappile pachakkari krishi. Krishi Vigyan Kendra, Central Marine Fisheries Research Institute, 44 pp.

Shoji Joy Edison and Shinoj Subramannian 2015 . Vilakalude roga keeda niyanthrana sahaayi (Ready reckoner for diseases and pests in common crops of Kerala). Krishi Vigyan Kendra, Central Marine Fisheries Research Institute, 100 pp.

Popular articles

Vikas P.A. and Pushparaj Anjelo, F. 2014. *Kulangalile Alankara Malsyakrishi* (Malayalam). Kerala Karshakan, June 2014.

Vikas P.A. and Shinoj Subramannian 2015. Jaiva Hormone AminoPlus. *Karshakasree.* February , 2015.

Conference/Workshop presentations

Pushparaj Anjelo, F. and Shinoj Subramannian 2015. Innovative farmers of Ernakulam: Selection and documentation. Bhartiya Vigyan Sammelan (BVS), Goa, 5-8 February, 2015.

Vikas P.A. and Shinoj Subramannian 2015. An indigenous practice of responsible brackishwater fish seed collection and supply. Bhartiya Vigyan Sammelan (BVS), Goa, 5-8 February, 2015.

Vikas, P.A., Shinoj Subramannian, John, Bose, Zacharia, P.U., Rao, G. Syda and Gopalakrishnan, A. 2014. Farm Gate Markets: An innovative approach for marketing quality fish at premium price. International Conference on Organic ++: Livelihoods – BioVillages – Markets, Adlux Convention & Exhibition Centre, Ernakulam District, Kochi, 7-8 November 2014.

Vikas, P.A. and Shinoj Subramannian 2015. Innovative initiative for enhancing inland fish production utilizing granite quarries: A case study from South India. Global Conference on Inland Fisheries, Food and Agriculture Organization (FAO) Headquarters, Rome, Italy, 26-28 January 2015.

PARTICIPATIONS

conferences, meetings, workshops, symposia, trainings, deputations

Participations

Dr. A. Gopalakrishnan, Director Follow up meeting of Cost Over Run chaired by Director General, ICAR at New Delhi, 11 April 2014

Reviewed the research and other activities of the Madras Research Centre, Chennai, 12 Ap ril 2014

Interactive meeting of Vice-Chancellors of Agricultural Universities and ICAR Directors at NASC Complex, New Delhi, 28 April 2014

24th meeting of the ICAR Regional Committee No. VIII at CTCRI, Trivandrum, 2-3 May 2014

Meeting with Kuwait delegation at NIO-CSIR, Goa; National Workshop on Marine Biodiversity at Karwar Research Centre of CMFRI; Inaugurated the cold storage facility at Karwar Research Centre of CMFRI; Inaugurated the nursery rearing facility of the marine cage farm developed at the CMFRI Annex at Kodibag, 21-23 May 2014

4th meeting of Scientific Panel of Fish and Fisheries Products at FSSAI, New Delhi, 26 May 2014

Inaugurated the harvest of sea cage farmed cobia under Technology Demonstration Programme of CMFRI; at Mandapam Camp; inaugurated the new Aquarium, Marine Finfish and Shellfish Seed Production Centre; and the National Training Programme on 'Marine Ornamental Fish Breeding and Aquarium Management Techniques' at Mandapam Regional Centre of CMFRI, Mandapam, 28 May 2014

IMC meeting of NBFGR at Lucknow, 2 June 2014

26th Scientific Advisory Committee (SAC) meeting of the Rajiv Gandhi Centre for Aquaculture (RGCA), at the Marine Products Export Development Authority (MPEDA), Kochi, 20 June 2014

22nd EFC meeting of 12th Plan of DARE/ICAR, at Krishi Bhavan, New Delhi, 16 - 18 July 2014

86th Foundation Day and ICAR Award Ceremony at ICAR, New Delhi, 29 July 2014

Conference of ICAR Directors and Vice-Chancellors of Agricultural Universities in the A.P. Shinde Auditorium, NASC, Pusa, New Delhi, 29-30 July 2014

Participated in the Independence Day function; Reviewed the research and other activities of Mandapam Regional Centre at Mandapam, 14-16 August 2014

Executive Development Programme on "Leadership Management" at NAARM, Hyderabad , 19-23 August 2014

India-Sri Lanka Joint Committee meeting at New Delhi, 29 August, 2014

Meeting withDr. Jose Graziano da Silva, Director General, FAO; Meeting of Vice Chancellors of Agricultural Universities and Directors of ICAR Institutes at New Delhi, 8 September 2014

Received the Indira Gandhi Rajabhasha Award from the Hon'ble President of India for the Best Official Language Implementation among the Central Govt. organizations in Region 'C' at Rashtrapati Bhavan Auditorium, New Delhi, 14 September 2014

5th meeting of Scientific Panel for Fish and Fisheries Products at New Delhi, 19 September 2014

Visited Visakhapatnam Regional Centre of CMFRI to assess the impact of Hud Hud cyclone on marine fishery sector and sea cage farming, 25-27 October 2014

35th meeting of the Board of Management of Kerala Veterinary and Animal Sciences University at Pookode, Wayanad, 30 October 2014

Kerala ICAR-SAU Interface Meeting chaired by the Union Minister of Agriculture Shri Radha Mohan Singh, at CMFRI, Kochi, 6 November 2015

10th Indian Fisheries and Aquaculture Forum at NBFGR, Lucknow, 12-15 November 2014

Vision 2050 meeting held at Krishi Bhavan, New Delhi, 19 November 2014

Reviewed the research and other activities of the Mandapam Regional Centre of CMFRI, at Mandapam, 28-30 November 2014

International Symposium on Marine Ecosystems Challenges and Opportunities-2, 2014 (MECOS-2, 2014) organized by the Marine Biological Association of India at Kochi, 2-5 December 2014

Cage Harvest Mela organized by CMFRI, Kochi at Poothotta, Ernakulam (Dt.), 23 December 2014

Meeting with the Director, NBFGR and all other project partners regarding outreach project on "Fish Genetic Stocks" - Phase-II; Discussions on conduct of proposed CAA5 (at Kochi) at NBFGR Lucknow, 05-09 January 2015

Participated in the 66th Republic Day celebrations; at Veraval Regional Centre of CMFRI; Reviewed the research and other activities of the Centre; Addressed the joint staff meeting of the Regional Centres of CMFRI and the CIFT at Veraval, Visited the proposed site for the Residential Complex of the CMFRI and CIFT RCs, and the TSP Sea cage Farm site of the RC, 25-27 January 2015

BOBLME Indian Mackerel Genetics Data Analysis Workshop at Phuket, Thailand, 16-18 February 2015

Inaugurated the pre-launch Workshop of the Network Project on Mariculture and delivered a talk presenting the activities and budget allotted for the project at Karwar Research Cente, 24-27 February 2015

Visited the mariculture farm (finfish cage culture) at Uppunda in connection with the fish harvest mela inaugurated by the ADG (M.Fy), ICAR and interacted with the farmers of Uppunda Village at Mangalore, 27-30 February 2015

Dr. A.K. Abdul Nazar Training on 'Emotional Intelligence' at National Academy of Agricultural Research Management (NAARM), Hyderabad, 24-28 November 2014

RAG Review meeting to evaluate the progress of research projects sanctioned by Gulf of Mannar Biosphere Reserve Trust at Mandapam Regional Centre of CMFRI, 5 March 2015

Dr. A.K. Abdul Nazar and **Dr. R. Jayakumar** Visited Alampur Village, Purba, Medinipur District, West Bengal for giving technical guidance for initiating pompano farming in ponds, 16-20 April 2014

Visited Indo Aquatic Farm Ltd. at TP Gudurmandal, Nellore District, Andhra Pradesh, 21 April 2014

Dr. A.K. Abdul Nazar 'NICRA' review meeting at CMFRI Headquarters, Kochi during 29-30 January 2015

Blue Paper Forum - India Aquaculture Pathfinder organised by USSEC at Bangalore, 5-6 February 2015

Dr. A.K. Abdul Nazar and **Dr. R. Jayakumar** Pre-launch Workshop on implementation of 'All India Network Project' on Mariculture at Karwar Research Centre of CMFRI, Karwar, 25 February 2015

Dr. K.V. Akhilesh Regional workshop on the identification of deep-sea cartilaginous fishes of the Indian Ocean. Albion, Mauritius, 10–13 June 2014

Fourth Mission Meeting on Conservation of Sharks-India (NMCS-IV) held at ICAR-Central Institute of Fisheries Education (Deemed University), Mumbai, 22 January 2015

Dr. M.K.Anil Sandpit Workshop on "Global Research Partnership in Aquaculture" jointly organized by DBT, New Delhi, BBSRC UK and DFID UK, 23 - 26 February 2015 at Hotel Taj Vivanta, Trivandrum

Ms. Anulekshmi Chellappan Training cum workshop on use of GIS software at Veravel Regional Centre of CMFRI, 10-11 April 2014

Organized and participated in CHLORIFF's 3rd workshop on "GIS Based Spatio-Temporal Data Analysis and Modelling of Primary Productivity" at Mumbai RC of CMFRI, 15-16 April 2014

Rotary Club Sponsored workshop on Fish Hygiene, Safety and Marketing Awareness for Fisherwomen held at Mumbai Research Centre of CMFRI, 21 April 2014

Brainstorming session on oilsardines at Veraval RC of CMFRI, 09-11 September 2014.

Dr. P.S. Asha Inception Workshop on FAO-BOBLME projects on 'Participatory management and conservation of seahorses in the Gulf of Mannar, South-East Coast of India' and 'An evaluation of current conservation measures on sea cucumber stocks in Palk Bay and Gulf of Mannar of India' at Mandapam Regional Centre of CMFRI, 27 December 2014

Dr. N. Aswathy Visited Indian Institute of Spices Research as Expert for Total factor Productivity analysis for spices in India and prepared the draft work programme, 31 March to 2 April 2014

Dr. Boby Ignatius 22nd EFC meeting of 12th Plan of DARE/ICAR, at Krishi Bhavan, New Delhi, 16 - 18 July 2014

MDP on Priority setting, Monitoring and Evaluation of Agricultural Research Projects at NAARM, Hyderabad, 4 -8 August 2014

Blue Paper Forum - India Aquaculture Pathfinder organised by USSEC at Bangalore, 5-6 February 2015

Dr. A.P. Dineshbabu GIS Regional Workshop at Veraval Regional Centre of CMFRI, Veraval, Gujarat, 10-11 April 2014

GIS Regional Workshop at Visakhapatnam Regional Centre of CMFRI, Visakhapatnam, Andhra Pradesh, 25-26 April 2014

Brain storming session on "Insects related to Veterinary and Fisheries Sciences" at the National Bureau of Agriculturally Important Insects (ICAR), Bangalore, 2 August 2014

Meeting on the need for Mega floating Harbour off Mangalore coast convened by Deputy Commissioner, DK District at Mangalore, 26 August 2014

Workshop on use of best available science in developing and promoting best practices for trawl fishing operations in South and Southeast Asia (SSA)" as a country expert in trawl fishery of India at Bangkok, Thailand, 11-13 September 2014

Technical Review Committee meeting of the research activities of the College of Fisheries, Mangalore, 14 March 2015

Meeting at the Space Application Centre, Ahmedabad, 16-17 March 2015

Rajabhasha Avom Puraskar Vidhran Samaroha at the South and South Western Zone Hindi Officers meeting at Mangalore, 27 March 2015

Dr. R. Geetha Meeting for selection of Research Associate under ITMU funded scheme entitled "Intellectual Property Management and Transfer/Commercialization of Agricultural Technology Scheme" at CIBA, Chennai - As external member, 20 December 2014

Dr. Geetha Sasikumar Resource personnel for training 25 farmers, in mussel farming in the estuaries and brackishwater bodies, under the purview of Secondary Livelihood opportunities through fishery resources at the ICAR Research Complex, Goa, 20 March 2015

Dr. G. Gopakumar XXIV meeting of ICAR Regional Committee at Thiruvananthapuram, 2 - 3 May 2014

4th Meeting of State Project Steering Committee for GOI-UNDP project on 'Mainstreaming coastal and marine biodiversity conservation into production sector for Sindhudurg coast- Maharashtra', at Mumbai, 15 May 2014

22nd EFC meeting of 12th Plan of DARE/ICAR, at Krishi Bhavan, New Delhi, 16 - 18 July 2014

Harvest function of cage farmed Seabass at Chennai, 16 September 2014.

Dr. G. Gopakumar and **Dr. B. Johnson** Brainstorming workshop on interventions for the sustainable management of the Palk Bay organized under Indo-German CMPA Project in Palk Bay at Rameswaram, 25 September 2014.

Smt. P. Hema Sankari and **Dr. R. Geetha** Interactive Training Workshop on Methods of Valuation Ecosystem Services, Madras Research Centre of CMFRI, Chennai, 5-9 January 2015

Dr. Imelda Joseph Workshop on Aquaculture Policy of Kerala organized by Kerala State Government at CMFRI, Kochi, 24 May 2014

Fisheries Development Workshop for Officers of NABARD at Vijayawada, 15-17 October 2014

KVK Review Meeting (Zone VIII) 2014, as Expert Member, 5 - 8 May, 2014

Ms. Indira Divipala National Workshop on Fish Stock Assessment at Government Arts College, Kumbakonam, Tamil Nadu, as resource person, 19 - 20 August 2014

Dr. R. Jayakumar Brainstorming session on 'Good Aquaculture Practices' organized by National Academy of Agricultural Sciences (NAAS), New Delhi, 29-30 December 2014

AQUAQUARIA-2015 organized by Marine Products Export Development Authority (MPEDA) at Vijayawada, 20-21 February 2015

Dr. Jayasree Loka. Refresher Course on Agricultural Research Management held at NAARM, Hyderabad, 10-22 November 2014.

Dr. R. Jeyabaskaran Organized andpParticipated the 'Project Planning Meeting' related to IUCN_MFF Project entitled "Living Resources of Gulf of Mannar: Assessment of Key species and habitats for Enhancing awareness and for Conservation Policy formulation" at IUCN-MFF, Chennai, 23-25 July 2014

Presented the project proposal on 'Marine Mammals' before the Scientific and Technical Advisory Group for the CMPA project; organized by the MoEFCC and GIZ at New Delhi, 7 October 2014

Organized and participated as resource person in the workshop on Living Resources of Palk Bay and Gulf of Mannar organized by the IUCN-MFF and MSSRF at Thoothukudi, Tamil Nadu, 12 November 2014

Terminal Workshop on IUCN/MFF Regional Project on Gulf of Mannar held at New Delhi, 22- 23 December 2014

FAO-BOBLME Inception workshop held at Mandapam, 27 December' 2014

Workshop on "The Scientific basis of Estimating Potential Fisheries Yield Using Remotely Sensed Data", 6-7 February 2015

Dr. Joe K. Kizhakudan National Official Scientific Seminar on 'Approaches to aquatic sustainability' organized by CMFRI Rajbhasha Section, CMFRI Kochi and gave oral presentations on vulnerability of crustaceans to climate change and anthropogenic influences - awarded the III prize for best oral presentation, 29 April 2014

10th International Conference and Workshop on Lobster Biology and Management (10th ICWL) and gave an oral presentation on "Improving feed reception and larval survival through use of scyphozoan medusa as feed in scyllarid larviculture" in the session: Aquaculture, Nutrition and population Enhancement held at Cancun, Mexico, 18-23 May 2014

Stakeholder's Meet conducted by the IFAD assisted Post-Tsunami Sustainable Livelihoods Programme (PTSLP) of the Tamil Nadu Corporation for Development of Women (TNCDW) at Chennai, 9 June 2014

Participated in the Interview, representing the institute for a documentary film "Successful implementation of artificial reefs" based on the consultancy project

being carried out for IFAD-PTSLP on the installation of Artificial Reefs in the inshore waters of Tamil Nadu, 3 July 2014

Delivered lectures on "Reproductive biology of sand and spiny lobsters" and "Problems and prospects of seed production in lobsters" at the summer school "Technological advancements in the seed production of marine finfish and shellfish" organized at Regional Centre of CMFRI, Mandapam, 20 August to 9 September 2014

Training programme on 'Moving towards sustainable fisheries' as a part of World Food Day at Kovalam Field Laboratory - As resource person, 14-15 October 2014

Delivered lecture at the Fisheries Staff Training Institute for the training programme on "Capacity building to the excutive staff of fisheries department under National Agricultural Development Programme", November 2014

Delivered guest lecture at College of Fisheries, Fisheries Technology Institute, Ponneri on the topic "Crustacean Biology", 9 December 2014

Blue Paper Forum - India Aquaculture Pathfinder organised by USSEC at Bangalore, 5-6 February 2015

Dr. Joe K. Kizhakudan and **Dr. V. Srinivasa Raghavan** Protocol Officer, Parliamentary Committee on Agriculture, CIBA, Chennai, 30 January - 1 February 2015

Dr. B. Johnson Member in the selection committee to identify the beneficiaries in implementing the schemes on cage culture and ornamental fish culture under state balanced growth fund project by Department of Fisheries at Ramanathapuram, 25 August 2014

Resource person in the workshop for Fisher Community on the living resources of Palk Bay and Gulf of Mannar organized by MSSRF, Chennai at Ramanathapuram, Tamil Nadu, 15 December 2014

Resource person in FAO-TCP Thematic Workshop on Fishers' Livelihoods at, Chennai, Tamil Nadu organized by BOBP-IGO, 7 - 8 January 2015

Resource person in ICSF/BOBLME State-level Marine Fishworker Consultation on Implementation of FAO Small-Scale Fisheries Guidelines at Ramanathapuram, Tamil Nadu, 7 February 2015

Resource person in ICSF/BOBLME Subnational Workshop Implementing of FAO Small-Scale Fisheries Guidelines: India (East Coast) at Chennai, 6-7 March 2015

Dr. B. Johnson and **Dr. Amir Kumar Samal** Workshop on 'R' and 'QGIS' under the ChloRIFFS Project at Mumbai Research Centre of CMFRI, 15-16 April 2014

Dr. K.K. Joshi National Workshop on Marine Biodiversity & Climate Change' organized at Karwar Research Centre of CMFRI, 21- 22 May 2014.

Inception Workshop on FAO-BOBLME projects on 'Participatory management and conservation of seahorses in the Gulf of Mannar, South-East Coast of India' and 'An evaluation of current conservation measures on sea cucumber stocks in Palk Bay and Gulf of Mannar of India' at Mandapam Regional Centre of CMFRI, 27 December 2014

Dr. S. Jasmine National Workshop on Marine Biodiversity & Climate Change' organized at Karwar Research Centre of CMFRI, 21- 22 May 2014.

Dr. Josileen Jose Training programme on "MSC certification and eco-labelling for sustainable fisheries organized by Marine Stewardship Council, London at Kochi, 10 November 2014

Dr. Josileen Jose,**Dr. S. Lakshmi Pillai** and **Dr. Rekhadevi Chakraborty** National Official Language Scientific Seminar on "Approaches to Aquatic Ecosystem Sustainability" organized by CMFRI Rajbhasha Section at Kochi, 29 April 2014

Two weeks training programme on "Fish Stock Assessment and Management" organized by FRA Division, CMFRI, Kochi, 15-27 September 2014

Dr. Kajal Chakraborty Annual Meeting-cum-Workshop 2014 organised by ZTMC, CIFT in association with ITMU, IIHR at IIHR Bangalore, 9-10 October 2014.

Group meeting of the ICAR Platform project on Phytochemicals/High value compounds at IISR Calicut, 12 August 2014.

Meeting of Coordinated Research Project entitled "Energy in Agriculture/Algal biodiesel" at ICAR New Delhi under the Chairmanship of the Director General, ICAR, 9 June 2014

National Workshop on "Harnessing Intellectual Property for Strategic Competitive and Collaborative Advantage" at IIM, Ahmedabad, 20-22 June 2014

Invited Lead paper on "Marine Bioprospecting" at the UGC sponsored National Seminar at Department of Biotechnology, St. Peter's College, Kolenchery, Ernakulam District, Kerala, 2 September 2014

Dr. P. Kaladharan National Seminar on Algae for Sustainable Agriculture TNAU-Agricultural College and Research Institute, Madurai, 29-30 September 2014

10th Indian Fisheries and Aquaculture Forum at ICAR-NBFGR, Lucknow, 12-15 November 2014

Ms. Karthireddy Syamala CHLORIFF's 3rd workshop on "GIS Based Spatio-Temporal Data Analysis and Modelling of Primary Productivity" at Mumbai RC of CMFRI, 15-16 April 2014

Rotary Club Sponsored workshop on Fish Hygiene, Safety and Marketing Awareness for Fisherwomen held at Mumbai Research Center of CMFRI, 21 April 2014

Awareness Programme on "Conservation of sharks in Indian Seas" organized by Mumbai RC of CMFRI, 8 August 2014

CAFT training programme "Gender mainstreaming and development" organized by CIFE, Mumbai, 12-23 December 2014.

Dr. V. Kripa Organized and participated in the interactive meeting with the scientists of NIO, Kochi for discussing and finalizing sampling procedures related to Mud bank investigations at CMFRI, Kochi, 21 April 2014

Third National Communication on climate change organized by MoEF-NATLOMM and the programme on Impact-Adaptation-Mitigation in Marine Fisheries, 20-21 May 2014

Organized interactive meeting withDr. Ned Cyr, Director, National Marine Fisheries Service (NOAA) and Dr. Usha Varanasi, Former Director, Northwest Fisheries Science Center (NWFSC), NOAA, USA at CMFRI, Kochi, 08 August 2014

Clam Council Meeting held at Kollam Collectorate, Kollam, 12 August 2014

Attended the QRT review meetings at head quarters, Regional and Research Centres as Member Secretary, QRT during the period June 2014 to January 2015

Dr. P. Laxmilatha National Workshop on Marine Biodiversity & Climate Change' organized at Karwar Research Centre of CMFRI, 21- 22 May 2014.

Training programme on "MSC certification and eco-labelling for sustainable fisheries organized by Marine Stewardship Council, London at Kochi, 10 November 2014

Inception Workshop on FAO-BOBLME projects on 'Participatory management and conservation of seahorses in the Gulf of Mannar, South-East Coast of India' and 'An evaluation of current conservation measures on sea cucumber stocks in Palk Bay and Gulf of Mannar of India' at Mandapam Regional Centre of CMFRI, 27 December 2014

Dr. S. Lakshmi Pillai Training programme on "MSC certification and eco-labelling for sustainable fisheries organized by Marine Stewardship Council, London at Kochi, 10 November 2014

Dr. G. Maheswarudu Workshop on "Aquaculture Policy of Kerala" organized by Office of the Joint Director of Fisheries (Central Zone), Ernakulam, at CMFRI, Kochi, 24 May 2014

44th meeting of the Institute Management Committee of Central Institute of Brackishwater Aquaculture (CIBA), Chennai, 25 June 2014

Consultative workshop on "Benefits of MSC Certification of Astamudi Short Neck Clam Fishery" at CMFRI, Kochi organised by CMFRI and the World Wide Fund for Nature (WWF), 4 September 2014

45th meeting of the Institute Management Committee of Central Institute of Brackishwater Aquaculture (CIBA), Chennai, 18 December 2014

Scientific Advisory Committee (SAC) meeting of KVK, Narakkal held at CMFRI, Kochi, 10 February 2015

Dr. G. Maheswarudu and **Dr. S. Lakshmi Pillai** Workshop on "GIS based resources mapping of distribution and abundance of finfishes and shellfishes for east coast of India" at Visakhapatnam RC, 25-26 April 2014

Dr. A. Margaret Muthu Rathinam Brainstorming meeting conducted by the Pelagic Fisheries Division on the Indian oil sardine *Sardinella longciceps* at the Veraval Regional Centre of CMFRI, 9-11 September 2014

Training programme on 'Moving towards sustainable fisheries' as a part of observance of World Food Day at Kovalam Field Laboratory, MRC of CMFRI, Chennai- Served as resource person, 14-15 October 2014

Training-cum-Dissemination workshop on the "Findings and Outcomes of the FIMSUL-I Project" organized by the Food and Agriculture Organization of the United Nations (FAO) and the Bay of Bengal Programme Inter-Governmental Organisation (BOBP-IGO) at Chennai, 7 November 2014

Dr. A. Margaret Muthu Rathinam and **Dr. Vidya Jayasankar** "Aquaculture Chennai-2014, Sustainable Shrimp Farming - the Way Forward" Conference organized by the Tamil Nadu Fisheries University at Chennai, 13-14 June 2014

National workshop on 'Aquaculture of Sea Bass - Status and Way Forward for Commercial Production' jointly organized by the Fisheries Technocrats Forum and Central Institute of Brackish water Aquaculture (CIBA) at CIBA, Chennai, 28 January 2015

Dr. A. Margaret Muthu Rathinam ,Dr. K. Vijayakumaran,Dr. Joe K. Kizhakudan,Dr. Vidya Jayasankar,Dr. Shoba Joe Kizhakudan, Er. P. Hemasankari,Dr. V. Srinivasa Raghavan,Dr. R. Geetha and **Ms. Indira Divipala** Hindi workshop on 'Learning Hindi for day to day affairs' conducted as part of the Official Language Implementation activities at Madras Research Centre of CMFRI, 30 July 2014

"Farm Innovators' Day" jointly organized by the Madras Research Centre of CMFRI and CIBA to commemorate World Food Day at CIBA, 16 October 2014

Interactive workshop on 'Combating corruption-Technology as an enabler', as part of the Vigilance Awareness Week observed at the Research Centre of CMFRI, Chennai, 1 November 2014

Stakeholders meeting in capture fisheries held at MRC of CMFRI, Chennai, 11 December 2014

Brainstorming session on 'How to improve the use of Hindi in office work' conducted as

part of the Official Language Implementation activities at Madras RC of CMFRI, 18 December 2014

Hindi workshop on 'Spoken Hindi' conducted as part of the Official Language Implementation activities at MRC of CMFRI, 30 March 2015

Dr. Margaret Muthu Rathinam,Dr. K. Vijayakumaran,Dr. Joe Kizhakudan,Dr. Vidya Jayasankar,Dr. Shoba Joe Kizhakudan, Er. Hemasankari,Dr. Srinivasa Raghavan and **Dr. R. Geetha** Open House activities on the occasion of CMFRI Foundation Day at Kovalam Field Lab of Madras RC of CMFRI, Chennai, 11 February 2015

Dr. K.S. Mohamed Meeting withDr. Usha Varanasi, Former Director, Northwest Fisheries Science Center (NWFSC) and Dr. Ned Cyr, Director, National Marine Fisheries Service NOAA, USA at CMFRI, Kochi, 8 August 2014

Ashtamudi Lake Clam Council meeting at Kollam Collectorate, Kollam, 12 August 2014

Delivered a lecture on 'Trophic modeling of Aquatic Ecosystem' in the Training programme on "Fish stock assessment and management" organized at CMFRI, Kochi, 27 September 2014

Meeting on findings of case study on Ashtamudi Lake and guiding case study on Seasonal fishing ban at New Delhi by GIZ India, 25 September 2014

Workshop on "Marine Ecosystem Characterization-India" at NIO, Goa sponsored by BOBLME, 20-22 October 2014

Conducted the launch event of MSC certification of the Ashtamudi Short-Neck Clam Fishery, Kerala organized by CMFRI and WWF-India at CMFRI, Kochi, 5 November 2014

Organized the International Symposium on Marine Ecosystems Challenges and Opportunities - 2, 2014 (MECOS-2, 2014) by the Marine Biological Association of India, Kochi, as Convener, 2-5 December 2014

Delivered a talk in the Special Session: Aquaculture and Marine Biotechnology for Human Health in the 102nd Indian Science Congress organized by the University of Mumbai at Kalina Campus, Mumbai University, 6 January 2015

Scientific Advisory Committee meeting of Krishi Vigyan Kendra at CMFRI, Kochi, 10 February 2015

Delivered a presentation on "Aquaculture of bivalves" in the Aqua Aquaria India 2015 at Vijayawada, Andhra Pradesh organized by MPEDA, 20 - 22 February 2015

ICSF-BOBLME Sub-National Workshop: implementing the FAO SSF guidelines: India (East Coast), Chennai, 6-7 March 2015.

Resource person in the One Day Seminar on "Kerala Laws on Environment: Current Trends and Judicial Responses" at National University of Advanced Legal Studies (NUALS), Kalamassery, Kochi, 8 March 2015

Dr. Molly Varghese National Workshop on Marine Biodiversity & Climate Change' organized at Karwar Research Centre of CMFRI, 21- 22 May 2014.

Smt. M. Muktha Training on e-publishing for IJF editorial committee members at CMFRI HQ, Kochi, 1-2 September 2014

CMFRI Vision 2050 document preparation meeting at CMFRI, Kochi, 8-13 December 2014

Stakeholder meeting held at RC of CIFT, Visakhapatnam, 17 March 2015

Smt. M. Muktha, Sri. Loveson Edward and **Sri. Rajendra Naik** Workshop on CHLORIFFS Project at Mumbai RC of CMFRI, 16 April 2014

Smt. M. Muktha and **Sri. Loveson Edward** Delivered a lecture on research activities of CMFRI in workshop for fisherwomen of Visakhapatnam district organized by the District Fishermen's Youth Welfare Association (DFYWA), 24 July 2014

DST sponsored training on Geospatial Technologies at Andhra University, 1-21 December 2014

Workshop on "The Scientific Basis of Estimating the Potential Fisheries Yield Using Remotely Sensed Data" at CMFRI, Kochi, 6-7 February 2015

Dr. R. Narayanakumar 22nd EFC meeting of 12th Plan of DARE/ICAR, at Krishi Bhavan, New Delhi, 16 July 2014

CMFRI VISION 2050 document presentation of CMFRI at ICAR, Krishi Bhavan New Delhi, 19 November 2014

RFD Mid-Term Review Meeting of Fisheries Research Institutes held at Fisheries Division, ICAR, New Delhi, 20 November 2014

Dr. R. Narayanakumar,Dr. N. Aswathy and **Dr. R. Geetha** Interactive Training Workshop on Valuation of Ecosystem Services at Chennai Research Centre of CMFRI, Chennai, 5-9 January 2015

Dr. Nilesh A. Pawar Summer School on "Technological Advancements in the Seed Production of Marine Finfish and Shellfish" ICAR-CMFRI, Mandapam Regional centre, Mandapam, 20 August 2014 to 09 September 2014

Dr. Prathibha Rohit 24th Meeting of the ICAR Regional Committee VIII at CTCRI, Sreekaryam, Trivandrum, Kerala, 2-3 May 2014

Management Development Programme on Leadership Development at NAARM, Hyderabad, 15-26 July 2014

Technical and financial evaluation (TFE) meeting for finalizing the satellite tags for SATTUNA Project at INCOIS, Hyderabad, 7-9 August 2014

Pre-final meeting of the National Fisheries Management Code, Kochi at CMFRI, Kochi 30 October 2014 to 1 November 2014

Dr. Prathibha Rohit,Dr. A.P. Dineshbabu and **Dr. Sujitha Thomas** Workshop on National Biodiversity and Climate Change at Karwar RC of CMFRI, Karwar 21 May 2014

Dr. M.A. Pradeep International workshop on Fish Genomics, at CIFE, Mumbai, 19-21 January 2015

International Workshop on Aquatic Animal Disease Surveillance (IWAADS), at NBFGR, Lucknow. 15 November 2014

International workshop on Fish Genomics, at CIFE, Mumbai.19-21 January 2015

Sri. Pralaya Behera Workshop on Fish conservation methods and technologies organized by District Fishermen's Youth Welfare Association (DFYWA), Visakhapatnam- - as resource person, 15 May 2014

National workshop on Biodiversity and Climate change at Karwar RC of CMFRI, Karwar, 21-22 May 2014

Training on open water SCUBA diving conducted by ANCOST-NIOT at Port Blair, 15-21 December 2014

International Expo 'Aqua Aquaria 2015' conducted by MPEDA, Kochi at Vijayawada, 20-22 February 2015

Dr. D. Prema and **Smt. G. Shylaja** 10th Kerala Environment Congress (KEC 2014) organized by Centre for Environment and Development (CED) held at Kochi with focal theme "Water and Energy security-Issues, Challenges and Potentials", 22-23 August 2014

Dr. G. B. Purushottama CHLORIFF's 3rd workshop on "GIS Based Spatio-Temporal Data Analysis and Modelling of Primary Productivity" at Mumbai RC of CMFRI, 15-16 April 2014

Awareness Programme on "Conservation of sharks in Indian Seas" organized by Mumbai RC of CMFRI, 8 August 2014

Fourth Mission Meeting on Conservation of Sharks-India (NMCS-IV) held at ICAR-Central Institute of Fisheries Education (Deemed University), Mumbai, 22 January 2015

Blue Paper Forum - India Aquaculture Pathfinder organised by USSEC at Bangalore, 5-6 February 2015

Dr. I. Rajendran and **Shri. R. Saravanan** National Seminar on "Algae for Sustainable Agricultural Production" held at Agricultural College & Research Institute, Madurai,

29 - 30 September 2014

Dr. I. Rajendran,Dr. B. Johnson and **Shri. R. Saravanan** Regional seminar on "Current Status and Future Prospect of Coastal and Marine Biodiversity in Gulf of Mannar" organized by GOMBRT, Ramanathapuram in Rameswaram, 23 January 2015

Mr. S. Ramkumar CHLORIFF's 3rd workshop on "GIS Based Spatio-Temporal Data Analysis and Modelling of Primary Productivity" held at Mumbai RC of CMFRI, 15-16 April 2014

National Workshop on "Marine Biodiversity and Climate Change" organized by Karwar Research Centre of CMFRI, Karwar, 21-22 May 2014

Organized one-day Stakeholders' Meet under the UNDP Sindhudurg Cetacean Project at Malvan, 05 June 2014

Organized and coordinated series of training programmes for creating awareness regarding rescue and post-mortem analysis of beached or stranded cetaceans along Sindhudurg coastline, Maharashtra, for department officials of Forest, Customs, Port, Marine police, Veterinary doctors and State fisheries department and fisher folks from Devgad, Malvan and VengurlaTaluk of District Sindhudurg under the UNDP Sindhudurg Cetacean Project at Malvan, 9-11 July 2014 (Fisherfolk), 20-21 June 2014, 24-25 July 2014 and 7-8 August 2014

Dr. P. Ramesh kumar National Symposium on "Impact of Climate Change on Pathobiology of Diseases of Animals, Poultry and Fish" organized by College of Veterinary Science and Animal Husbandry, Anand Agricultural University, Anand, 13-15 November 2014

Dr. Ritesh Ranjan Global Tilapia Summit held by MPEDA at Vijayawada, 18 December 2014

Annual Review Meeting of the NBSFARA "Stock characterization, captive breeding, seed production and culture of hilsa (*Tenualosa ilisha*)" project held at New Delhi, 10-12 February 2015

Pre-launch workshop of the All India Network Project on Mariculture at Karwar RC of CMFRI, 25 February 2015

Dr. M. Sakthivel Stakeholders Meet under the GOI-UNDP-GEF funded project on 'Development of protocols and capacity building of local authorities and people of Sindhudurg district of Maharashtra' at Malvan, Sindhudurg, Maharashtra, 5 June 2014

Dr. Sandhya Sukumaran International workshop on NGS Bioinformatics Technologies (NGBT) at Bangalore, 15-16 November, 2014

Data sharing workshop in connection with the project on Genetic study on breeding stock of Indian Mackerel, *Rastrelliger kanagurta* along the Indian coast funded by FAO-BOBLME at Phuket, Thailand, 17-18 February, 2015

Shri. N.K. Sanil and **Dr. M.A. Pradeep** 10th IFAF International workshop on Aquatic Animal Disease Surveillance (IWAADS) at Lucknow, 12- 15 November 2014

Shri. R. Saravanan National workshop on "Marine Biodiversity and Climate Change" at Karwar Research Centre of CMFRI, 21-22 of May 2014

World Ocean day celebration at M S Swaminathan Research Foundation (MSSRF), Thangatchimadam, 6 June 2014

Dr. Sekar Megarajan DBT sponsored national seminar on "Immuno-molecular techniques and its application" as resource person at the Centre for Advanced Studies in Marine Biology, Faculty of Marine Sciences, Annamalai University, Parangipettai, Tamil Nadu, 12-13 September 2014

Expert committee meeting on the "Effect of Hud-Hud cyclone" at Andhra University, 16 December 2014

Dr. Shoba Joe Kizhakudan Awareness programme on "Shark Conservation" at Satpati fishing village, Palghar Dt., Maharashtra, organized by Mumbai RC of CMFRI - As resource person, 8 August 2014

Capacity building workshop on CITES Appendix II listing of sharks and *Manta* ray species convened by the Ministry of Environment, Forests and Climate Change (MoEF&CC), Government of India in collaboration with C.P.R. Environmental Education Centre (CPREEC) (a centre of Excellence of the MoEF&CC) and Humane Society International (HSI) and gave an invited talk on "Overview of India's Shark Fisheries." India at Chennai, 26 to 28 August 2014

Training programme on "e-publication" conducted for editorial committee members of the Indian Journal of Fisheries at CMFRI, Kochi, 1-2 September 2014

Third National Mission Meeting on Conservation of Sharks-India (NMCSI-3) organized by the Association of Deep Sea going Fishermen (ADSGF), Bay of Bengal Programme - Inter-Governmental Organization (BOBP-IGO) and Humane Society International (HSI) and delivered the keynote address at Mangaluru, Karnataka, 20 November 2014

Dr. Shoba Joe Kizhakudan and **Dr. R. Geetha** Fishermen meeting for feedback assessment on the reef fishery, in connection with the installation of the artificial reef under the IFAD-PTSLP consultancy project at the Kovalam Field Laboratory of the Madras Centre, 15 July 2014

Fishermen meeting for feedback assessment on the reef fishery, in connection with the installation of the artificial reef under the IFAD-PTSLP consultancy project at Anichankuppam (Villupuram District), 18 July 2014

Dr. Shoba Joe Kizhakudan and **Ms. Indira Divipala** Workshop on the project "GIS based resource mapping of distribution and abundance of finfishes and shellfishes off Indian coast for suggesting operational based strategies for fisheries management" for training on use of two softwares - Geomedia and ERDasat, Visakhapatnam Regional Centre of CMFRI, Visakhapatnam, 25- 26 April 2014

Dr. Shoba Joe Kizhakudan and **Dr. Vidya Jayasankar** Organised "Hindi Week" events at Madras RC of CMFRI Chennai, 15-19 September 2014

Dr. Shubhadeep Ghosh Regional Committee Meeting for Zone-2 at CIFRI, Barrackpore, 27-28 June 2014

Meeting on "Development of Fisheries Management Plans for West Bengal" at CIFRI, Barrackpore, 30 August 2014

Brainstorming meeting on oilsardines at Veraval RC of CMFRI, 9-11 September 2014

Second Co-ordination Committee meeting of the NBSFARA "Stock characterization, captive breeding, seed production and culture of hilsa (*Tenualosa ilisha*)" project at New Delhi, 18 September 2014

National Consultation Meeting conducted by BOBLME for the Andaman Seas at Port Blair,17-19 December 2014

NICRA review meeting at CMFRI, Kochi during 28 and 29 January 2015

Global Conference on Agribusiness Innovations and Contract Research held at Visakhapatnam, 3 February 2015

Innovations in Agri-business at Visakhapatnam, 24 February 2015

Dr. Shubhadeep Ghosh, Smt. M. Muktha and **Sri. Rajendra Naik** Workshop on installation and use of Geo Media software held at Visakhapatnam RC of CMFRI, 25-26 April 2014

Dr. Shubhadeep Ghosh and **Dr. Ritesh Ranjan,** 4th Advisory Committee Meeting for the NBSFARA "Stock characterization, captive breeding, seed production and culture of hilsa (*Tenualosa ilisha*)" project at CIFRI, Barrackpore, 8-10 July 2014

Dr. Shubhadeep Ghosh and **Sri. Rajendra Naik** Interactive session with the members of the Women Collective Project of DFYWA at VRC of CIFT, 6 August 2014

Dr. Shyam S. Salim Meeting with social team of GULLS (Ingrid Van putten (Australia) James Howard (SA) Alistair Hobday project for having discussion on finalizing the survey, sampling strategies and sampling size, 4 September 2014

Acted as *Chief De Mission* of CMFRI sports team, facilitated and organized "sports team building" activities within the institute for the South Zone ICAR Sports Meet, 2014 held at IIHR Bengaluru. The CMFRI sports team won overall 3rd position, 13-18 October 2014

Fifth meeting of Project Appraisal and Monitoring Committee (PAMC) on Ocean Science and Resources in the Ministry of Earth Sciences (MoES), New Delhi and presented the Annual Progress Report (2014 - 2015) on GULLS Project, 23-24 March 2015

Dr. K.S. Sobhana Workshop on "Impact of capacity building programs under NAIP" jointly organized by NAIP, ICAR and the International Food Policy Research Institute (IFPRI) at NASC Complex, Pusa, New Delhi, 6 - 7 June, 2014

DBT Task Force meeting on Aquaculture and Marine Biotechnology at DBT, New Delhi, 24 -25 July, 2014

Sandpit Workshop on "Global Research Partnership in Aquaculture" jointly organized by DBT, New Delhi, BBSRC UK and DFID UK, 23 - 26 February 2015 at Hotel Taj Vivanta, Trivandrum

Dr. P.S. Swathi Lekshmi Meeting conducted by the State Fisheries Resource Management

Committee (FIRMA) in association with the State Fisheries Department, Government of Kerala and presented a talk on the Indigenous Technical Knowledge of Marine Fisher folk at Kochi Kerala, 27 December 2014

Meeting conducted by the State Fisheries Resource Management Committee (FIRMA) in association with the State Fisheries Department, Government of Kerala and presented a talk on the Indigenous Technical Knowledge of Marine Fisher folk at Cannanore, Kerala, 14 February 2015

Dr. Veerendra Veer Singh Brain Storming Session on Coastal Agricultural Research" held at the Central Coastal Agricultural Research Institute, Goa, 9 April 2014

Participated and Chaired the Session on Climate Change in National Workshop on "Marine Biodiversity and Climate Change" at Karwar organized by Karwar RC of CMFRI, 21-22 May 2014

2nd meeting of the Advisory Committee of the NFBSFARA Project at I.C.S. College, Khed, 6 May 2014

Organized and participated in "World Environment Day Celebration" at Mumbai Research Centre of CMFRI, 5 June 2014

Workshop on "Discussion on Mithi River Rejuvenation" at Worli organized by National Environmental Engineering Research Institute (NEERI), 5 June 2014

Presided over and delivered the welcome address in the Awareness Programme on "Conservation of Sharks in Indian Seas" organized by Mumbai RC of CMFRI in collaboration with The Satpati Fishermen Co-operative Society Ltd., Satpati & Satpati Macchimaar Vividh Karyakari Saharkari Sanstha Maryadit, Satpati at Satpati, Palghar Taluka & District, Maharashtra, 8 August 2014

Indo- Norwegian Workshop for working group on fisheries and aquaculture at Mumbai, 30 October 2014

Fourth Mission Meeting on Conservation of Sharks-India (NMCS-IV) held at ICAR-Central Institute of Fisheries Education (Deemed University), Mumbai, 22 January 2015

Dr. V. Venkatesan Training programme on "Fish Stock Assessment and Management" held at CMFRI, Kochi, 5-27 September 2014

Dr. R. Vidya 99th Foundation Course for Agricultural Research Service (FORCARS) held at NAARM, Hyderabad, 1 January 2014 to 31 March 2014

Orientation Training at CMFRI, Cochin, 9 April 2014 to 16 May 2014

Professional Attachment Training (PAT) as per the FOCARS guidelines at National Institute of Oceanography (NIO), Regional Centre, Kochi, 19 May 2014 to 18 August 2014

Training on "Identification of commercial marine fishes and CMFRI fish catch and effort estimation methodology" at CMFRI Hqrs., Kochi, 20 August 2014 to 25 September 2014

Training on Fishery Resources Assessment and data collection under the Fishery Resources Assessment Division (FRAD) of CMFRI, Kochi, 26 September 2014 to 22 October 2014.

Dr. K. Vinod Inception Workshop on FAO-BOBLME projects on 'Participatory management and conservation of seahorses in the Gulf of Mannar, South-East Coast of India' and 'An evaluation of current conservation measures on sea cucumber stocks in Palk Bay and Gulf of Mannar of India' at Mandapam Regional Centre of CMFRI, 27 December 2014

Dr. Vidya Jayasankar Refresher Course on Agricultural Research Management at Hyderabad at NAARM, Hyderabad,14 - 26 July 2014

Dr. P. Vijayagopal Delivered an invited lecture on fish nutrition and feed technology at a Farmers Meeting organized by the FFDA Kannur on 08-01-2015

Presented Lead paper on "Marine Bioprospecting" at the UGC sponsored National Seminar at Department of Biotechnology, St. Peter's College, Kolenchery, Ernakulam District, Kerala, 2 September 2014

Blue Paper Forum - India Aquaculture Pathfinder organised by USSEC at Bangalore, 5-6 February 2015

Dr. K. Vijayakumaran Meeting with the DAHDF, Ministry of Agriculture for the 18th session of the Indian Ocean Tuna Commission (IOTC), New Delhi, 12 May 2014

Meeting of the project team for the project titled "Economics of Biodiversity Loss: A study of the by-catch from Andhra Pradesh Marine Fisheries" at CESS, Hyderabad, 21 September 2014.

6thRegional Training Course on the Code of Conduct for Responsible Fisheries and delivered the key-note address entitled Regional initiatives in management of shared and common resources - Examining reality and exploring possibilitiesconducted by the Bay of Bengal Programme Inter-Governmental Organisation (BOBP-IGO) at Chennai, 20 September - 2 October 2014

Seminar on Fisheries Sector and Coastal Zone Development organized by the A.K.G. Study and Research Centre, Thiruvanathapuram and presented a paper on 'Changing Deep Sea Fisheries Policies: The Science, Economics and Impact on Fishermen' at Alleppey, Kerala, 17 February 2015

ICSF-BOBLME India (East Coast) workshop: Implementing the FAO Voluntary Guideline for Securing Sustainable Small-scale Fisheries in the Context of Food Security and Poverty Eradication held in Chennai, 6-7 March 2015

Dr. K. Vijayakumaran and **Dr. Shoba Joe Kizhakudan** Stakeholder's meet conducted by the Association of Deep-Sea Going Fishermen (ADSGF), Thuthoor, towards discussions on the preparation of a National Plan of Action for shark fishing in India and presented a talk on the biological aspects of sharks which make them particularly vulnerable to fishing impacts and the current status of their landings in India at Chennai, 25 July 2014

ICSF/BOBLME State-level Marine Fish worker Consultation on Implementation of FAO Small-scale Fisheries Guidelines at Chennai, 5 February 2015

Dr. P. U. Zacharia,Dr. R. Narayanakumar,Dr. M.S. Madan,Dr. Shoji Joseph,Dr. C. Ramachandran,Dr. M.K. Anil.Dr. B. Santhosh,Dr. S. Jasmine,Dr. A.K. Abdul Nazar,Dr. R. Jayakumar,Dr. I. Rajendran, Shri. R. Saravanan, Shri. Chandrasekar,Dr. V.P. Vipinkumar.,Dr. Shaym S. Salim,Dr. P.S. Swathi Lekshmi,Dr. N. Aswathy,Dr. R. Geetha,Dr. Shubhadeep Ghosh,Dr. Ritesh Ranjan,Dr. Biji Xavier, Smt. M. Muktha, Sri. Loveson Edward,Dr. Sekar Megarajan,Dr. A. Margaret Muthu Rathinam,Dr. Joe K. Kizhakudan, Smt. P. Hemasankari,Dr. V. Srinivasa Raghavan,Dr. R. Geetha, Ms. Indira Divipala,Dr. Sandhya Sukumaran,Dr. V. Venkatesan,Dr. R. Vidya,Dr. G.B. Purushottama, Shri. S. Ramkumar 10th Indian Fisheries and Aquaculture Forum at National Bureau of Fish Genetic Resources, Lucknow, 12-15 November 2014

Dr. P. U. Zacharia,Dr. K.S. Mohamed,Dr. V. Kripa,Dr. K. K. Joshi,Dr. Imelda Joseph,Dr. P. Kaladharan,Dr. Josleen Jose,Dr. Shoji Joseph,Dr. D. Prema,Dr. Molly Varghese,Dr. Lakshmi Pillai,Dr. U. Ganga,Dr. Rekaha J. Nair,Dr. R. Jeyabaskaran,Dr. A.K. Abdul Nazar,Dr. Sandhya Sukumaran and **Dr. K.V. Akhilesh** First World Ocean Science Congress - 2015, jointly organised by Swadeshi Science Movement, Kerala and Kerala University of Fisheries and Ocean Studies, Kochi at Kochi, Kerala, 5-8 February 2015

All scientists from CMFRI Hqs, Kochi,Dr. A. Margaret Muthu Rathinam,Dr. Joe K. Kizhakudan, Ms. Indira Divipala,Dr. Shubhadeep Ghosh, and **Miss F. Jasmin** National Official Language Scientific Seminar on "Approaches to Aquatic ecosystem Sustainability", CMFRI Kochi, 29 April 2014

All scientists of CMFRI International Symposium on Marine Ecosystems Challenges and Opportunities-2, 2014 (MECOS-2, 2014) organized by the Marine Biological Association of India, Kochi, 2-5 December 2014

Deputation abroad

Dr. A. Gopalakrishnan, Director Data sharing workshop in connection with the project on 'Genetic study on breeding stock of Indian Mackerel, *Rastrelliger kanagurta* along the Indian coast' funded by FAO-BOBLME at Phuket, Thailand, 17-18 February, 2015

Dr. A.P. Dineshbabu Workshop on use of best available science in developing and promoting best practices for trawl fishing operations in South and Southeast Asia (SSA)" as a country expert in trawl fishery of India at Bangkok, 11-13 September 2014

Dr. Grinson George,Dr. Rekha J. Nair and **Dr. Somy Kuriakose** Summer School organized by Integrated Marine Biogeochemistry and Ecosystem Research (IMBER ClimEco4) on delineating the Issues of Climate Change and Impacts to Marine Ecosystems: Bridging the Gap between Research, Assessment, Policy and Management, at East China Normal University, Shanghai, China, 4-9 August 2014

Dr. K. K. Joshi Second workshop on the Ecosystem Characterisation of the Bay of Bengal Large Marine Ecosystem organised to consolidate and validate the information collected by the CSIRO project team on BOBLME, at Bangkok, Thailand 3 - 5 November 2014

Dr. B. Johnson International Short Course on 'Fisheries Governance' at Centre for Development Innovation, Wageningen University, Wageningen sponsored by Netherlands Government (Netherlands Fellowship Programme (NFP)/TP-fellowship), 31 October to 24 November 2014

Dr. V. Kripa Invited lecture on Climate change impacts on India's marine fisheries in the 3rd International Conference on Effects of climate change on world oceans held at Brazil, 22-28 March 2015

Dr. S. Lakshmi Pillai 10th IOTC Working Party meeting on Ecosystems and Bycatch (WPEB10) in Tokyo, Japan, 26 October to 1 November 2014

Dr. K.S. Mohamed Meeting of Working Group on Fisheries Standards Review of the

Marine Stewardship Council (MSC) in London, 29-30 April 2014

Participated in the BOBLME Ecopath–Ecosim ecosystem modeling workshop at Phuket, Thailand, 8-12 September 2014

Meeting of Technical Advisory Board (TAB) of the Marine Stewardship Council (MSC) at Paris, France, 11-12 December 2014

Dr. Prathibha Rohit First workshop on connecting the IOTC Science and Management Processes (SMWS01), Phuket, Thailand, 25-27 June 2014

Fourth session of IOTC working party on Neretic tunas (WPNT 04), Phuket, Thailand, 29 June - 2 July 2014

17th Scientific Committee meeting of IOTC at Seychelles, 8-12 December 2014

Dr. Rekha J. Nair 2014. 9th International Flatfish Symposium hosted by The National Oceanic and Atmospheric Administration's Alaska Fisheries Science Centre and the International Pacific Halibut Commission at Cle Elum, Washington, USA, 10 November 2014

Dr. Sandhya Sukumaran Data sharing workshop in connection with the project on 'Genetic study on breeding stock of Indian Mackerel, *Rastrelliger kanagurta* along the Indian coast' funded by FAO-BOBLME at Phuket, Thailand, 17-18 February, 2015

Dr. Shyam S. Salim Skype Meet with the Brazilian participants of 2nd Workshop on the project "Global Learning for Local Solutions: Reducing Vulnerability of Marine Dependent Coastal Communities" (GULLS) held at Ubatouba, University of Sao Paulo, Brazil, 17 March 2015

Dr. Sunil Mohammed and **Dr. K. K. Joshi** Training workshop on "Application of ECOPATH with ECOSIM (EwE)" at Phuket, Thailand sponsored by the Bay of Bengal Large Marine Ecosystem (BOBLME), 8 -12 September, 2014

Dr. K. Vinod. Exposure Visit to Scientific Institutions and Laboratories in Russia, 13-19 September 2014.

Dr. P. U. Zacharia,Dr. Prathibha Rohit,Dr. R. Narayanakumar,Dr. T. V. Sathianandan,Dr. Shyam S. Salim and **Dr. P.S. Swathilekshmi** Belmont forum funded– GULLS Workshop at Rhodes University, Grahamstown, South África, 1-5 April 2014

Krishi Vigyan Kendra, Narakkal

Smt. N.V. Dipti Training programme on Organic certification and internal control system at the Directorate of Extension, Kerala Agricultural University, Thrissur, 14 - 18 October 2014

Training on Zero budget farming of Subhash Palekar at Gandhi Museum, Madurai, 24–27 January 2015

Dr. F. Pushparaj Anjelo HRD Training Programme on Technology management by KVK professionals held at National Academy of Agricultural Research Management, Hyderabad, 9 -11 June 2014

Training programme on Participatory Impact Monitoring and Assessment (PIMA) held at KVK, Mysooru, 5-10 December 2014

4th Bharathiya Vigyan Sammelan organised by Vigyan Bharathi in association with Govt. of Goa and Goa University held at Kala Academy, Panaji - Goa and presented paper entitled "Innovative farmers of Ernakulam: Selection and documentation", 7 February 2015

Dr. Shinoj Subramannian Brainstorming session on creating and sustaining interest in agriculture among youth jointly organized by The Hindu and National Agricultural Research System (NARS) at ICAR-Central Institute for Brackishwater Aquaculture (CIBA), Chennai, 25 October 2014

High level committee meeting to review the performance of KVKs to suggest measures to improve their functioning at National Academy of Agricultural Sciences, New Delhi, 29 December 2014

Project planning workshop on Attracting and Retaining Youth in Agriculture (ARYA) at National Academy of Agricultural Research Management (NAARM), Hyderabad, 11-12 March 2015

Dr. Shinoj Subramannian,Dr. Shoji Joy Edison and **Dr. F. Pushparaj Anjelo** Workshop on collaborative programmes between KVK's in Kerala, organized by Kerala Agricultural University, Thrissur, 20 June 2014

Dr. Shinoj Subramannian, Smt. P. Sreeletha,Dr. F. Pushparaj Anjelo,Dr. Shoji Joy Edison,Dr. Vijendra Kumar Meena and **Dr. P.A. Vikas** Network workshop of KVKs of Kerala on family farming held at Wayanad, 26-28 May 2014

Dr. Shoji Joy Edison Participated in the district level Farmer-Scientist interface programme (KissanGoshti) at NAS Auditorium, Kalady, 19 December 2014.

Dr. Shoji Joy Edison and **F. Pushparaj Anjelo** Project initiation meeting on "Enhancing the Economic Viability of Coconut Based Land Use Systems for Land Use Planning in Kerala State" held at Kerala State Planning Board office, Pattom, Thiruvananthapuram, 6 March 2015

Smt. P. Sreeletha Workshop on Frontier Home Science Technologies held at University of Agricultural Sciences, Darward, 28-30 October 2014

Dr. P.A. Vikas Exposure visit to Central Institute for Brackishwater Aquaculture (CIBA), Chennai, 3-5 July 2014

National Fish Farmers day celebrations organized by Cochin University of Science and Technology (CUSAT) and delivered a lecture on "Indian Aquaculture: Prospects and practices", 10 July 2014

Indo German Water Partnership Conference organized by SCMS School of Engineering and Technology and Corporation of Cochin, Kochi, 06 October 2014

International Conference Organic ++: Livelihoods - BioVillages - Markets by International Competence Centre for Organic Agriculture at ADLUX Convention & Exhibition Centre, Kerala, 7-08 November 2014

Stakeholders interaction meet organized by ICAR-Central Institute for Brackishwater Aquaculture (CIBA), Chennai, 12 December 2014

Zonal Workshop on National Mission on Agricultural Extension and Technology (Focus on Extension and IT) for States in South India (AP, Telangana, Karnataka, Kerala and Tamil Nadu) at Kakkanad, 9 January 2015

Dr. P.A. Vikas Participated and presented a paper in the "Global Conference on Inland Fisheries" organized by FAO Headquarters, Rome, Italy, with Fellowship from Science and Engineering Research Board of DST, Govt. of India, 26-28 January 2015

NOMINATIONS

Dr. A. GOPALAKRISHNAN, Director, CMFRI

Member, Institute Management Committee (IMC), National Academy of Agricultural Research Management (NAARM), Hyderabad

Member, Board of Management (BoM), Central Institute of Fisheries Education (CIFE), Mumbai

ICAR Representative-Board of Management (BoM), Member, Grievance Committee and Ex-Officio Member-Management Council (MC) of Kerala, Veterinary and Animal Sciences University (KVASU), Pookkode, Wayanad

ICAR Representative, Board of Management (BoM) of Kerala University of Fisheries & Ocean Studies (KUFOS), Panangad, Kochi

Expert Member, Committee for Construction of Bio-Security Laboratory and Quarantine Facility at Central Island Agricultural Research Institute (CIARI), Port Blair, Andaman & Nicobar Islands

Member, Scientific Advisory Committee (SAC) Rajiv Gandhi Centre for Aquaculture (RGCA), Sirkali, Tamil Nadu

Panel Member, Scientific Panel of Fish and Fisheries Products, Food Safety and Standards Authority of India' (FSSAI) (Govt. of India)

Member, Institute Management Committee (IMC), National Bureau of Fish Genetic Resources (NBFGR), Lucknow

Member, Advisory Committee, Zoological Survey of India (ZSI - Ministry of Environment, Forests and Climate Change, Govt. of India), Kolkata

Member, Indo-Sri Lanka, Joint Committee on Fisheries Officials from India to look into the aspects of Fishermen, MoU and Mutual Corporation, Ministry of Agriculture, Department of Animal Husbandry, Dairying and Fisheries (DAHD&F), Govt. of India

Chairman, Technical Committee (TC) to Review the Duration of the Trawl Ban Period and to suggest further measures to strengthen the Conservation and Management

Elected as Vice-Chairman, Asian Fisheries Society Indian Branch (AFSIB) on 14 November 2014 for a period of three years.

Member, Governing Body ICAR – New Delhi

Member, Board of Studies (Zoology), Maharaja's College (Autonomous), Ernakulam, Kochi

Member, Expert Group to review Schedule-I of the Wildlife (Protection) Act 1972 Member, National Coastal Zone Management Authority (NCZMA), New Delhi

Member, Editorial Board, Indian Journal of Animal Sciences

Member, Governing Body, National Institute of Fisheries Administration & Management (NIFAM), (Government of Kerala), East Kadungallur, Alwaye

Dr. Sunilkumar Mohamed, HOD, Molluscan Fisheries Division

Member, Technical Advisory Board (TAB) of Marine Stewardship Council (MSC), London, UK

Member, Ashtamudi Clam Fisheries Governing Council, Kollam

Dr. V. Kripa, HOD, Fisheries Environment Management Division (FEMD)

Member, Institute Management Committee, CIFT, Cochin

Member, Academic Council, Kerala University of Fisheries and Ocean Studies, Cochin

Dr. P.U. Zacharia, HOD, Demersal Fisheries Division (DFD)

Co-opted member, Technical Committee (TC) to review the duration of the trawl ban period, Govt. of Kerala, and to suggest further measures to strengthen the Conservation and Management Aspects nominated by Chairman of the Committee

Editor, Journal of the Marine Biological Association of India

Member, Board of Studies (Fisheries Management), Kerala University of Fisheries and Ocean Studies, Cochin

Member, Advisory Committee of Cochin Fisheries Harbour

Dr. Prathibha Rohit, HOD, Pelagic Fisheries Division & SIC, Mangalore Research Centre

Member of expert panel at Karnataka Biodiversity Board, Karnataka

Elected Chairperson of Indian Ocean Tuna Commission, Seychelles, for the Working party on Neritic Tunas for two bienniums since 2010 to 2015

Dr. G. Maheswarudu, HOD, Crustacean Fisheries Division

Member, Institute Management Committee, CIBA, Chennai

Member, Board of studies, Marine Living Resources, Andhra University, Visakhapatnam

Dr.R.Narayanakumar, HOD, Socio Economic Evaluation and Technology Transfer Division (SEETD)

Member, Selection committee, Technical Assistant recruitments, Central Institute of Fisheries Technology, Cochin

External Examiner for M.FSc and Ph.d programme of CIFE.Mumbai for the course Fishery Economics & Management

Examiner for Tamil Nadu Fisheries University, Nagapattinam for three courses in Fishery Economics and Marketing.

Co-chair, 10th IFAF Socio economics and fisheries held at NBFGR, Lucknow, November 11-15, 2014

External Examiner, Comprehensive M.F.Sc . examinations, CIFE. Mumbai

Dr. C. S. Purushothaman, Principal Scientist and SIC, HRD

Expert Member in the Indo-Norway Committee of the Department of Biotechnology, Govt. of India for monitoring the research projects in aquaculture and marine biotechnology under the Indo-Norway collaborative programme

Dr. P. Kaladharan, Principal Scientist, FEM Division

Member, Abstract Committee to the International Symposium MECOS-2 organized by the MBAI at Cochin during 2-5th December 2014.

External Member in the DPC of ICAR- Indian Institute of Spices Research, Kozhikode

Resource Person for the ICAR sponsored Winter School on Recent Advances in the Development of Nutraceuticals , Health Foods and Fish Feed from Fish and Shell fish Processing Discards at ICAR-CIFT

Member, Board of Studies- Aquaculture, Calicut University, Kozhikode

External Expert in the Selection Committee for selection of Research Assistant in the ICAR- Indian Institute of Spices Research, Kozhikode

Centre Superintendent to one of the Centres at Cochin to the ICAR's 20th All India Entrance Examination for admission to UG Degree Programme

Coopted to contribute inputs on coastal and marine environment and resources for the preparation of State Report of Environment -2015 (SOE-2015) by KSCSTE, Sasthra Bhawan, Trivandrum.

Dr. Molly Varghese, Principal Scientist, Marine Biodiversity Division (MBD)

Member, Organizing Committee for conduct of the Technical Session on "Living Resources – Exploited Stocks" in the World Ocean Science Congress, 2015 at Jawaharlal Nehru International Stadium, Kochi from 5 – 8 February, 2015.

Member, Departmental Promotion Committee for considering promotion to the post of Joint Director at Coir Board, Kochi

Dr. Rekha J. Nair, Senior Scientist, (DF D)

Commission Member, Species Specialist Group on Groupers (IUCN) for the period 2013-16

Dr. Veerendra Veer Singh, Scientist-in-Charge, Mumbai Research Centre

CMFRI representative, One-day brainstorming session on " Coastal Agricultural Research" at Central Coastal Agricultural Research Institute (CCARI),

Member, Departmental Promotion Committee (DPC), in Fishery Survey of India, Mumbai

CMFRI Representative, Indo-Norwegian Workshop for working group on fisheries and aquaculture, Mumbai

Member/ CMFRI Representative, 23rd Meeting of ICAR Regional Committee No. VII organised by ICAR-Central Institute for Cotton Research (CICR, Nagpur) at Raipur

Member, One-day Workshop of Indian Nitrogen Group at CIFRI, Barrackpore

CMFRI representative, Sixteenth meeting of the consultative committee of the fisheries survey of India at FSI (HQ) Botawala chambers, Mumbai

Member, Board of Studies (BOS), Fisheries Economics, Extension and Statistics Division of ICAR-Central Institute of Fisheries Education (CIFE), Versova, Mumbai

Member/CMFRI Representative, Sixth State Project Steering Committee (SPSC) for GoI-UNDP-GEF project on "Mainstreaming coastal and marine biodiversity conservation into production sectors in the Sindhudurg Coast, Maharashtra"

CMFRI Representative, District Advisory Committee meetings of Sidhudurg, Thane, Palghar and Ratnagiri Districts , Maharashtra) to confer opinion on purse seine Committee recommendations on fishing ban, deep sea fishing policy and other fisheries related issues of Maharashtra

Member, Taraporevala Aquarium Renovation Committee, constituted by Commissioner of fisheries, Govt. of Maharashtra.

Dr.P.K.Asokan, Principal Scientist & Scientist-in-Charge, Kozhikode Research Centre of CMFRI,

Member, Institute Management Committee, ICAR - Indian Institute of Spices Research, (IISR), Kozhikode

Mr. K. Mohammed Koya, SIC, Veraval Regional Centre

Co-opted member in the Board of Studies (Fisheries Faculty) of the Junagadh Agri. University, Junagadh, Gujarat.

Member in the Scientific Advisory Committee of Krishi Vigyan Kendra (KVK), Ambuja Cement Foundation, Kodinar, Junagadh, Gujarat

Member in the Lokvani Advisory Committee of the Community Radio Station, Krishi Vigyan Kendra (KVK), Ambuja Cement Foundation, Kodinar, Junagadh, Gujarat

Member in the Technical Committee of Gujarat Marine National Park and Marine Sanctuary Conservation Society, Ministry of Environment and Forests, Govt. of Gujarat

Invited Member in the AGRESCO of the Junagadh Agri. University, Junagadh, Gujarat

Dr. A.K. Abdul Nazar, Senior Scientist & SIC, Mandapam Regional Centre

RAG member, Gulf of Mannar Biosphere Reserve Trust (GOMBRT), Government of Tamil Nadu, Ramanathapuram, Tamil Nadu.

Member- Fish, Fisheries and Aquaculture Sectional Committee, FAD 12 of Bureau of Indian Standards, Government of India, New Delhi.

Dr. I. Jagadis, Principal Scientist, Tuticorin Research Centre

Member of Administrative/Technical Committee for providing subsidy to purchase Self Contained Underwater Breathing Apparatus (SCUBA) to Chank Divers in Thoothukudi Dt., Tamil Nadu

Dr. K. K. Philipose, SIC, Karwar Research Centre

Member, Institute Management Committee (IMC), ICAR Research complex for Goa, Goa

Member, Institute Management Committee (IMC), CIFRI, Barrackpore

Member, Institute Management Committee (IMC), Central Marine Fisheries Research Institute

Member, District Task force for the fisheries development of Uttarkannada District, Karnataka

Dr. Shinoj Subramanian, PC and SIC, Krishi Vigyan Kendra, Ernakulam

Ernakulam district Agricultural Technology Management Agency (ATMA) Governing Board Member.

Ernakulam district Agricultural Technology Management Agency (ATMA) Management Committee Member

Advisory committee member of Union Bank of India Rural Development and Self Employment Training Institute, Perumbavoor, Ernakulam

Dr. Sujitha Thomas, Principal Scientist, Mangalore Research Centre

Member, Advisory committee of MFSc and PhD programmes , College of Fisheries ,

Mangalore, Karnataka Veterinary, Animal and Fisheries Sciences University (KVAFSU) Bidar

Dr. Rajesh K. M., Senior Scientist, Pelagic Fisheries Division, Mangalore Research Centre

Member, Advisory committee of M.F.SC., and Ph.D programmes, College of Fisheries, Karnataka Veterinary, Animal and Fisheries Science University (KVAFSU), Bidar

Dr. Shyam.S.Salim, Senior Scientist, SEETTD

Member, Academic Council, Kerala Agricultural University

Member, Advisory Committee of Cochin Fisheries Harbour under the Cochin Port trust

Academic Supervisor and Research mentor for Ms. Julia Novak Colwell, Student of Michigan State University for the post-doctoral fellowship work with Full bright-Nehru scholarship

Dr. R. Jayakumar, Senior Scientist, Mandapam Regional Centre

Co-opted Member- Fish, Fisheries and Aquaculture Sectional Committee, FAD 12 of Bureau of Indian Standards, Government of India, New Delhi.

Member - Board of Studies, Department of Animal Health Management, Alagappa University, Karaikudi

Dr. R. Jeyabaskaran, Senior Scientist, FEMD

Member- IUCN World Commission on Marine Protected Areas (IUCN-WCPA Marine)

Dr. M.A. Pradeep, Scientist, Marine Biotechnology Division

Expert member, technical committee for the establishment of Genomics lab for assisting selection of bulls through genomic selection, Kerala Livestock Development Board, Kerala

Mr. Raju Saravanan, Scientist, Marine Biodiversity Division

Member, IUCN Species Specialist Group(SSG) for snapper, seabream and grunt

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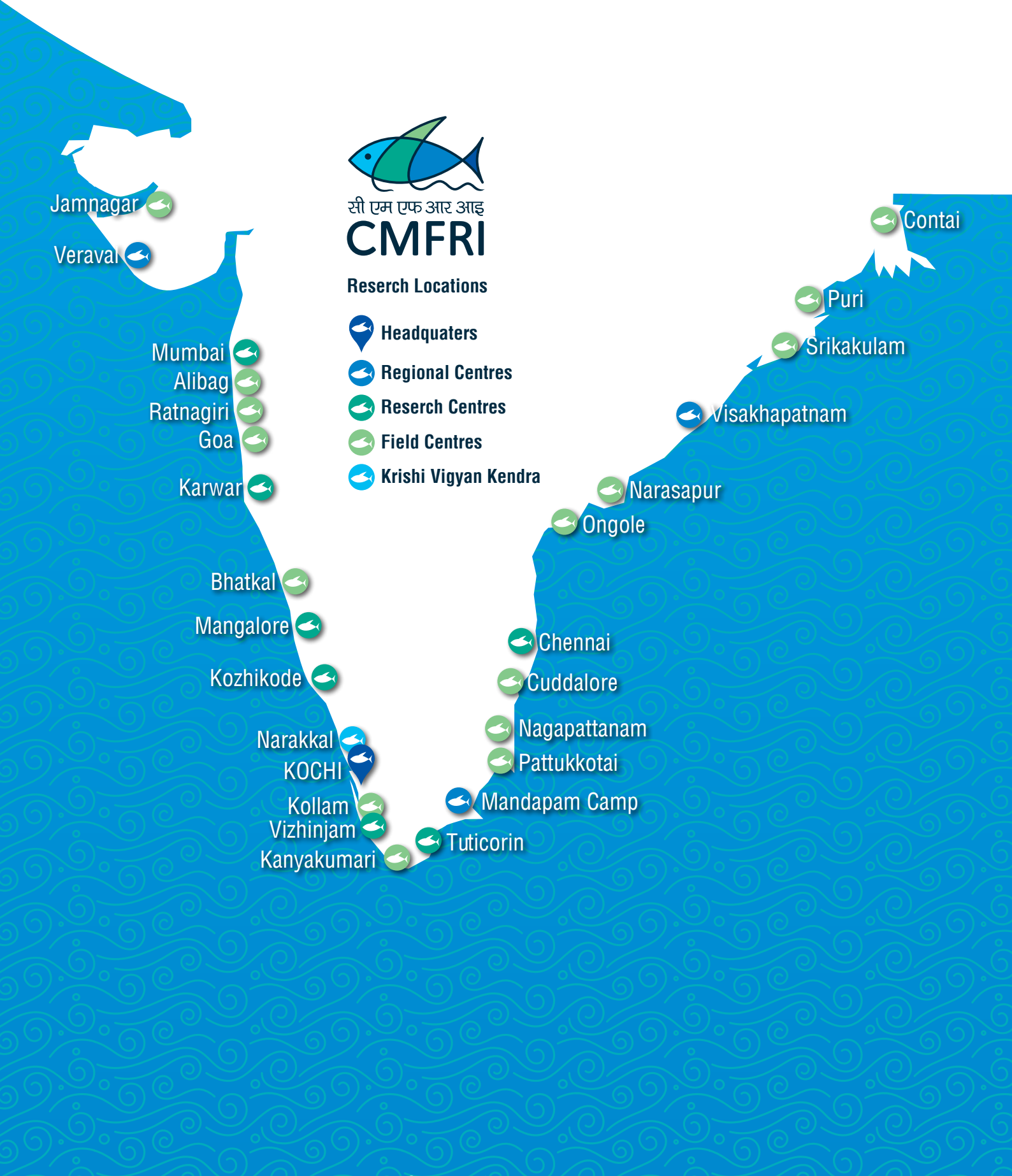

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